ASSESSMENT OF CLOSED WASTE DISPOSAL SITES

PHASE III

INVESTIGATION AND MONITORING

NEWTON LANDFILL SITE, CAMBRIDGE

AUGUST 1989

Environment Ontario

Jim Bradley
Minister

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NEWTON LANDFILL SITE, CAMBRIDGE

Report prepared for:
Waste Site Evaluation Unit
Waste Management Branch

Report prepared by:
M.M. Dillon Limited

AUGUST 1989

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EXECUTIVE SUMMARY

This report describes the results of a hydrogeological investigation of the Newton Landfill site in Cambridge. The investigation was initiated by the Ministry of the Environment because of a paucity of information regarding the site's hydrogeological setting and because of its proximity to two municipal water supply wells.

The landfill, some five hectares in area, is situated in predominantly coarse-grained ice contact and outwash deposits. Lateral ground water flow through the site is to the west towards the municipal wells, at velocities of approximately 15 to 25 m/yr.

However, the bedrock and deep overburden aquifer, from which the municipal wells draw, appears to be hydraulically confined by a layer of lower permeability till which underlies the granular deposits. Therefore, contamination of the municipal wells by leachate is unlikely.

Leachate generated at the landfill by infiltration and ground water throughflow is of a quality typical of weak to medium strength municipal landfill leachate. It is characterized by relatively high ionic strength and by BTX (benzene, toluene and xylene) and phenolic compounds.

A significant proportion of the leachate generated in the landfill is captured in an open drainage channel at the toe of the landfill slope on the downgradient side. The channel discharges to a manhole which in turn drains into the municipal sanitary sewer. The drainage channel is currently used by children as a playground. This practice should be strongly discouraged by improved fencing, sign-posting and public awareness.

There is also significant leachate contamination of the shallow ground water off-site. Immediately west of the landfill, ground water is contaminated to a quality unsuitable for drinking, to a depth of at least 6 m. There is evidence that the leachate plume has migrated in the shallow ground water at least 240 m to the west.

Observations of surface water discolouration in the swampy area northwest of the site, suggest that discharge of contaminated ground water is occurring in this area.

Off-site migration of leachate in the shallow ground water flow could be mitigated by installation of a subsurface collector system on the western side of the landfill. Leachate production could be significantly reduced at the site by reducing the permeability of the cover and improving the grading on top of the site.

The hydrogeological study also addressed the issue of methane gas production and migration at the landfill. The site is actively producing methane gas. Southward lateral migration of the methane gas towards the adjacent residential development has been identified. Under frozen ground conditions, when natural venting of the methane is not possible, the lateral migration will be enhanced. As such, an immediate potential hazard exists with respect to methane accumulation in the new houses.

To address this situation, a comprehensive methane monitoring program should be developed and coordinated with the present methane gas venting system implemented by the City of Cambridge. The installation of methane alarms should be considered for the basement of the houses closest to the landfill.

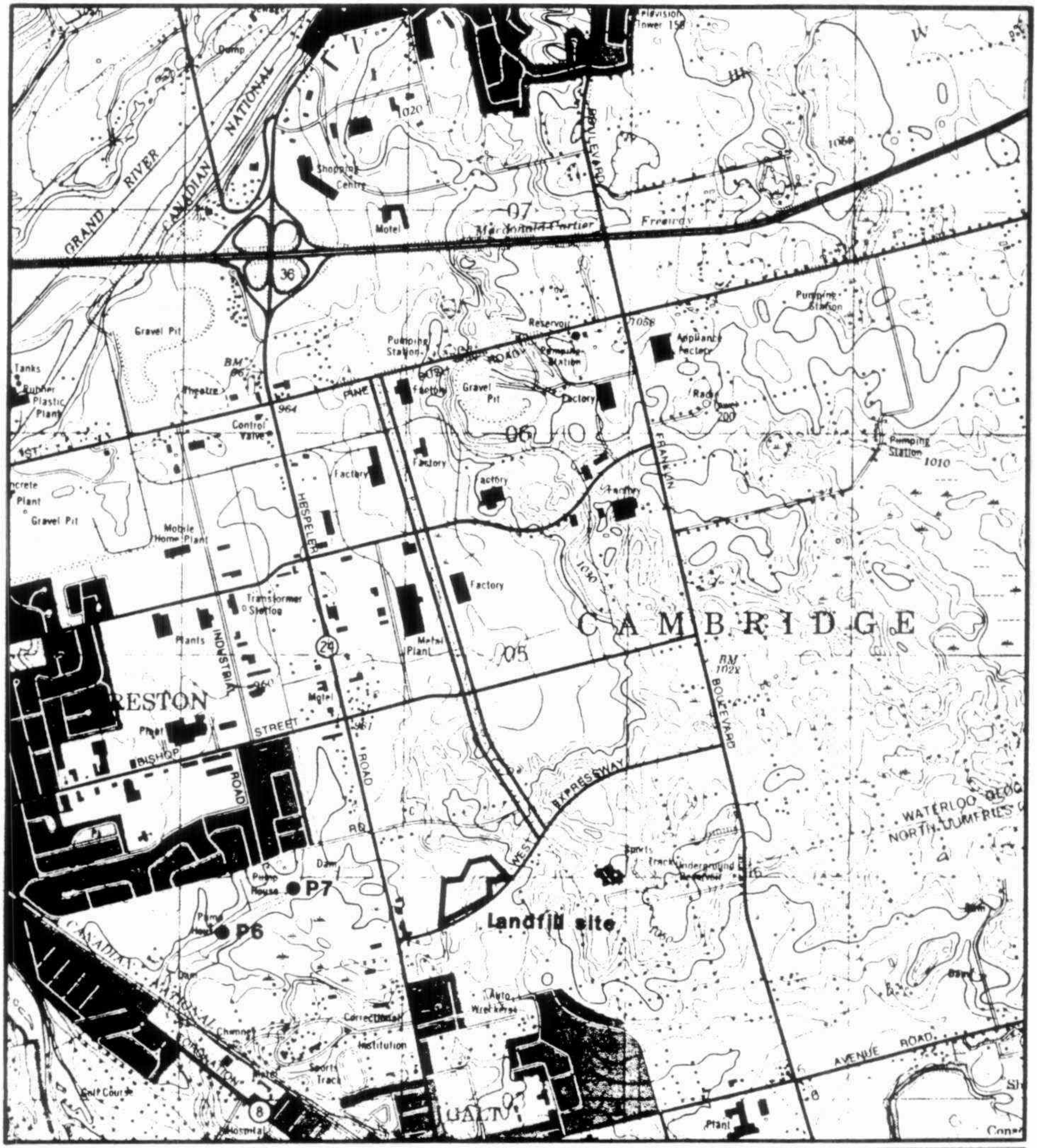
1. INTRODUCTION

In 1985 the Ministry of the Environment (MOE) initiated a comprehensive program to investigate and monitor all active and closed waste disposal sites in Ontario. The main purpose of the program is to determine the existing impacts and potential for future impacts on human and natural environments in the vicinity of sites previously used for waste disposal and to assess the need for remedial works to mitigate these impacts. The first two phases of the MOE program provided an inventory of landfill sites in the Province and established a priority for further investigations. Phase 3 of the program comprises the actual field investigations and assessment of impacts of individual sites.

In June 1988, M.M. Dillon Ltd. was retained to conduct a Phase 3 study on the Newton Landfill in Cambridge. The purpose of the hydrogeological study is to assess the impact of this waste disposal site on the quality of ground water and surface water at the site boundaries and to identify any need for remedial measures that may be required to prevent the migration of leachate and/or methane gas beyond the boundaries of the site.

1.1 Site Location

The Newton Landfill site is located in the City of Cambridge, approximately 5 km south of Highway 401 on the east side of Highway 24 (Figure 1). The entrance to the landfill is located along the south side of the Mitten Industries property. The land west of the landfill site along



Scale 1 : 25,000

0 500 1000m

NEWTON LANDFILL SITE

● P7 MUNICIPAL PUMPING WELL

Location Map

Figure 1

DILLON

Highway 24 is occupied by commercial and industrial buildings. A new subdivision of detached homes is located south of the landfill site and grading for additional housing units is ongoing on the lands east of the site. Two social clubs are located on the property adjacent to the northern boundary of the site.

1.2 Site Background

Prior to being used as a waste disposal site, this land, owned by the City of Cambridge (then the City of Galt), had two main physical features:

1. A zone of ground water discharge located in the northwest corner of the property. This is a swampy area and has an elevation of approximately 290 m.a.s.l.

2. A sandy plateau covering the majority of the remaining land at an elevation of about 300 m.a.s.l.

In 1968, the City of Cambridge received approval from the Department of Health to use the property as a short-term sanitary landfill site. The Municipal Works Department operated the landfill, extracting sand for construction projects and backfilling the excavation with domestic and light industrial waste. The filling began on the sandy plateau in the southwest corner of the site in 1968 and was completed in the northeast corner in 1973. As filling progressed northward off the sandy plateau, refuse was deposited over the swampy area.

During the five years of use, this site is reported to have received (MOE files):

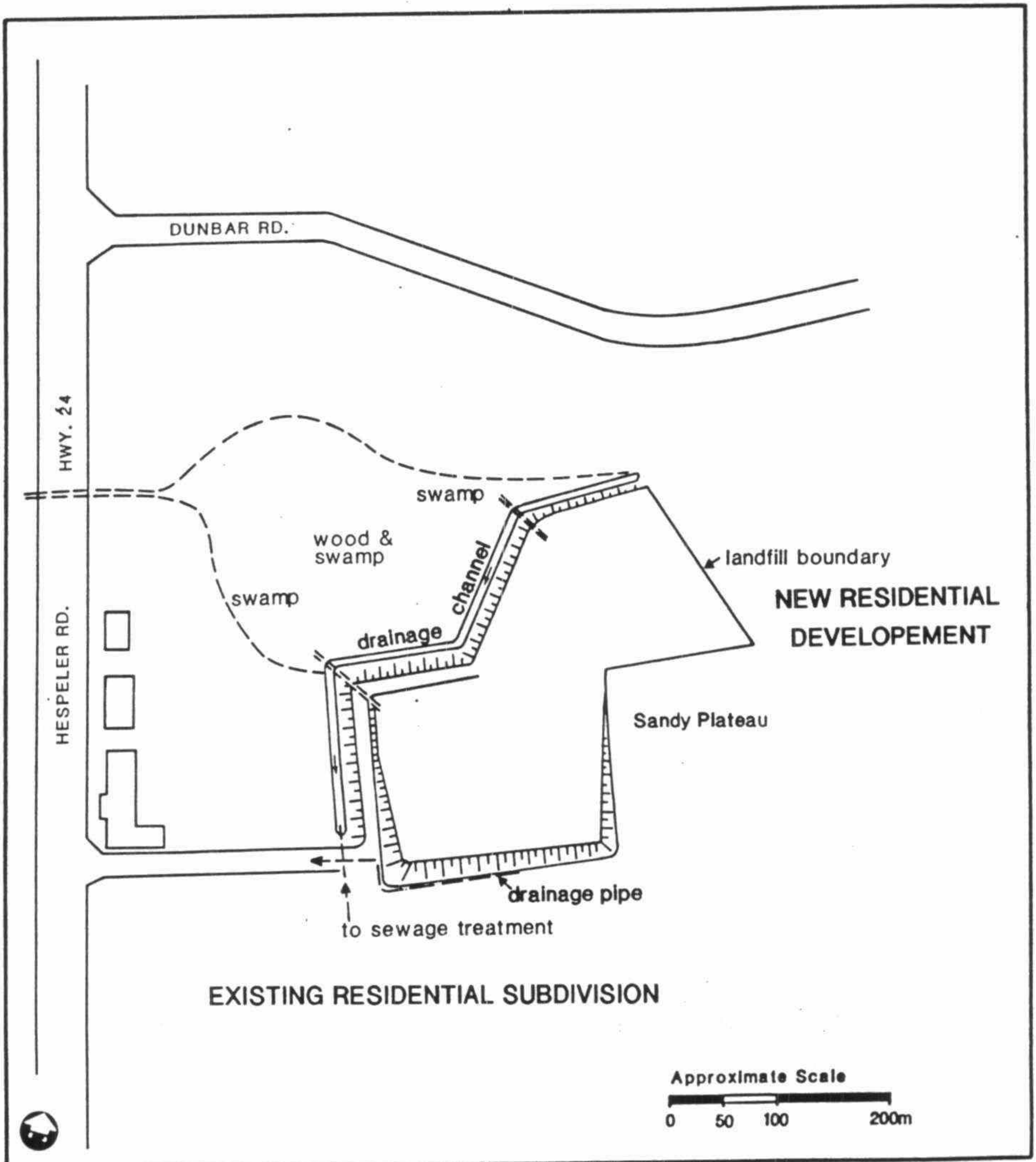
- soluble cleaning and cooling oil from Galt Metal Industries
- waste motor oils
- tolylene diisocyanate ($CH_3C_6H_3(NCO)_2$)
- chemicals from Canadian General Tower
- on occasion, sludge from the sewage treatment plant digestor.

According to the supervisor for the landfill site during its active life, there was no segregation of the waste into various components (i.e. liquid waste, cars, household waste).

As a result of extensive ground water flow into the excavation during the early stages of the landfill's active life, a perforated pipe was buried along the southern boundary. Approximately 120 m of pipe was buried at a depth of 5 m to collect ground water and feed it into the local sanitary sewer system.

A leachate collector system was built by the City of Cambridge prior to 1977 as a result of off-site leachate migration. This system is a rudimentary drainage channel which intersects the shallow ground water table (Figure 2). The channel is located along the northern and western edges of the landfill site. The channel diverts water into a catchbasin near the entrance to the landfill site which subsequently feeds the leachate into the local sanitary sewer system.

The City of Cambridge has had two methane gas studies performed at this site (Appendix A). A report submitted to the City in 1977 concluded that the landfill site was the source of significant methane gas production. A subsequent



NEWTON LANDFILL SITE

Site Features

Figure 2

DILLON

report completed in 1979 concerned itself with new development north and west of the landfill site. This report concluded that the depression (swamp) area northwest of the landfill (Figure 2) produced methane gas, and gas control measures should be considered for future and present structures along Highway 24 south of Dunbar Road.

Several well worn paths cross the landfill site and are used by local residents as shortcuts to John Galt Mall. On several occasions, during the course of this study, children were observed playing in the landfill area and within the drainage channel.

2. REGIONAL SETTING

2.1 Physiography and Climate

The Newton Landfill site is located in the Waterloo Hills physiographic region (Chapman and Putnum, 1966). Elevations in this region range between 290 and 370 m above sea level and generally decrease southward. The region is typified by irregular hills and ridges comprising sandy deposits with intervening swampy valleys. The Grand River spillway is a major physiographic feature which crosses the region and horizontal alluvial terraces are commonly found within the spillway.

The average annual temperature at this site is 7.5°C. A mean of 775 mm of rain and 124 mm of snow (as equivalent rainfall) falls for an annual total of 899 mm of precipitation (Environment Canada, 1982).

2.2 Regional Geology

The site area is typically covered by 15 to 50 m of overburden comprising four types of deposits (MOE, 1980):

1. Ice Contact Deposits

These consist of silt, sand and gravel deposited in moraines, kames and eskers which produce the irregular hilly terrain. These glacial deposits result from the stagnation of the Port Stanley and Wentworth ice sheets.

2. <u>Till</u>

This unit consists of poorly sorted material ranging from clay to gravel sized particles. The advance and retreat of several ice sheets resulted in the deposition of this dense material.

3. <u>Outwash Deposits</u>

These deposits consist of coarse sand and gravel. They are generally found along the Grand River spillway in horizontal strata resulting from the melt and retreat of the ice sheets.

4. <u>Lake Deposits</u>

These are fine grained deposits resulting from sedimentation in temporary pondings on top of spillway materials during and after the glacial retreat. These shallow water environments resulted in the development of swamp and marsh type vegetation.

Bedrock outcrops are generally restricted to river valleys where the overburden has been eroded away. The bedrock is a thick bedded grey and brown dolostone and is part of the Guelph Formation. The bedrock surface is mostly featureless and dips southwest.

2.3 Regional Hydrogeology

The highly permeable dolomites and limestones of the Guelph Amabel and Lockport formations constitute a high capacity source of water known as the Guelph Amabel aquifer. The

Cities of Cambridge and Guelph obtain their water supplies from it. Two municipal supply wells (P6 and P7) for the City of Cambridge are located some 800 m west of the landfill site (Figure 1). Well P6 is 80 m deep and is rated at 2000 m^3 per day (300 igpm). Well P7 is 85 m deep and has a yield of 650 m^3 per day (100 igpm). There were no records on file with the MOE of industrial or private ground water users within two kilometers downgradient of the landfill site.

Overburden sources of ground water are numerous in the area. A high yield area is found northeast of the site in Puslinch and North Dumfries Townships. The aquifer consists of 7 to 10 m of medium to coarse sand and gravel. This deposit overlies the bedrock and has been shown to be hydraulically connected to it (MOE, 1980). The aquifer appears to extend southwest through N. Dumfries Township east of the Grand River. Although no mapping of this aquifer is available the MOE report suggests that it underlies the Newton Landfill site. The aquifer is confined by a complex of lacustrine deposits interlayered with till. Ground water flow in this area is generally from north to south. However, the Grand River largely influences local ground water flow directions.

3. FIELD PROGRAM

A detailed description of the methodology and protocols used in the field program is included in Appendix B. Briefly, the field program consisted of the following elements:

- Drilling and installation of eight ground water monitors into native soil at various on and off-site locations (Figure 3). These comprised one single level piezometer (N2), three nests of one standpipe and one piezometer each (N1, N3 and N4) and one bedrock well (B1). Borehole logs are included in Appendix C.

- Drilling and installation of two standpipes into the waste for leachate monitoring and sampling (L1 and L2, Figure 3).

- Soil sampling with detailed descriptions and analyses. Grain size distribution curves are included in Appendix D.

- In-situ hydraulic testing of the various stratigraphic units. Rising head test data is included in Appendix E.

- Surface water sampling. All water quality data is included in Appendix F.

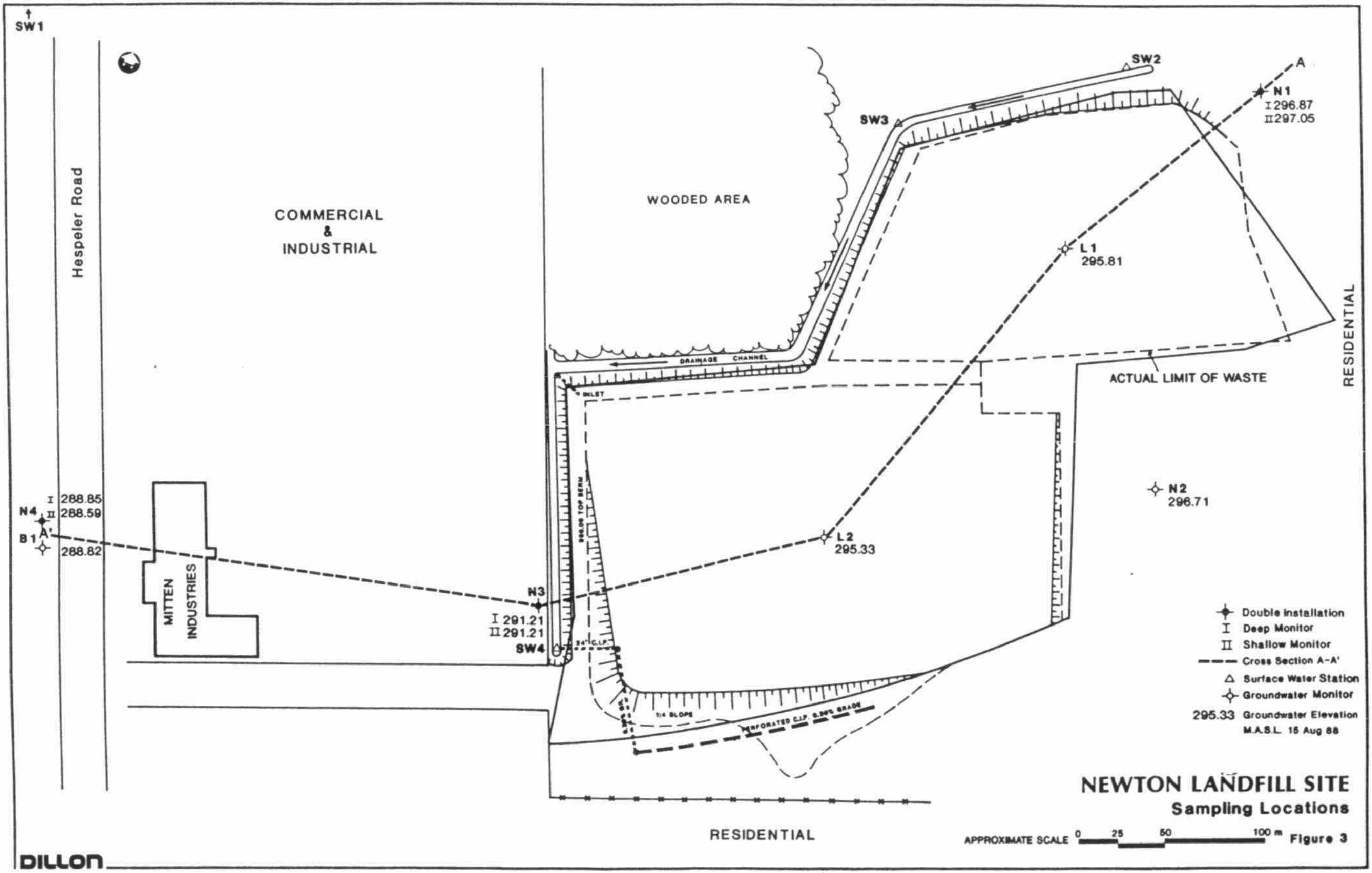
- Ground water sampling.

- Leachate sampling from within the waste.

- Methane gas monitoring.

- Water level measuring.

- Vegetation assessment.



NEWTON LANDFILL SITE
Sampling Locations
Figure 3

4. RESULTS

4.1 Site Geology

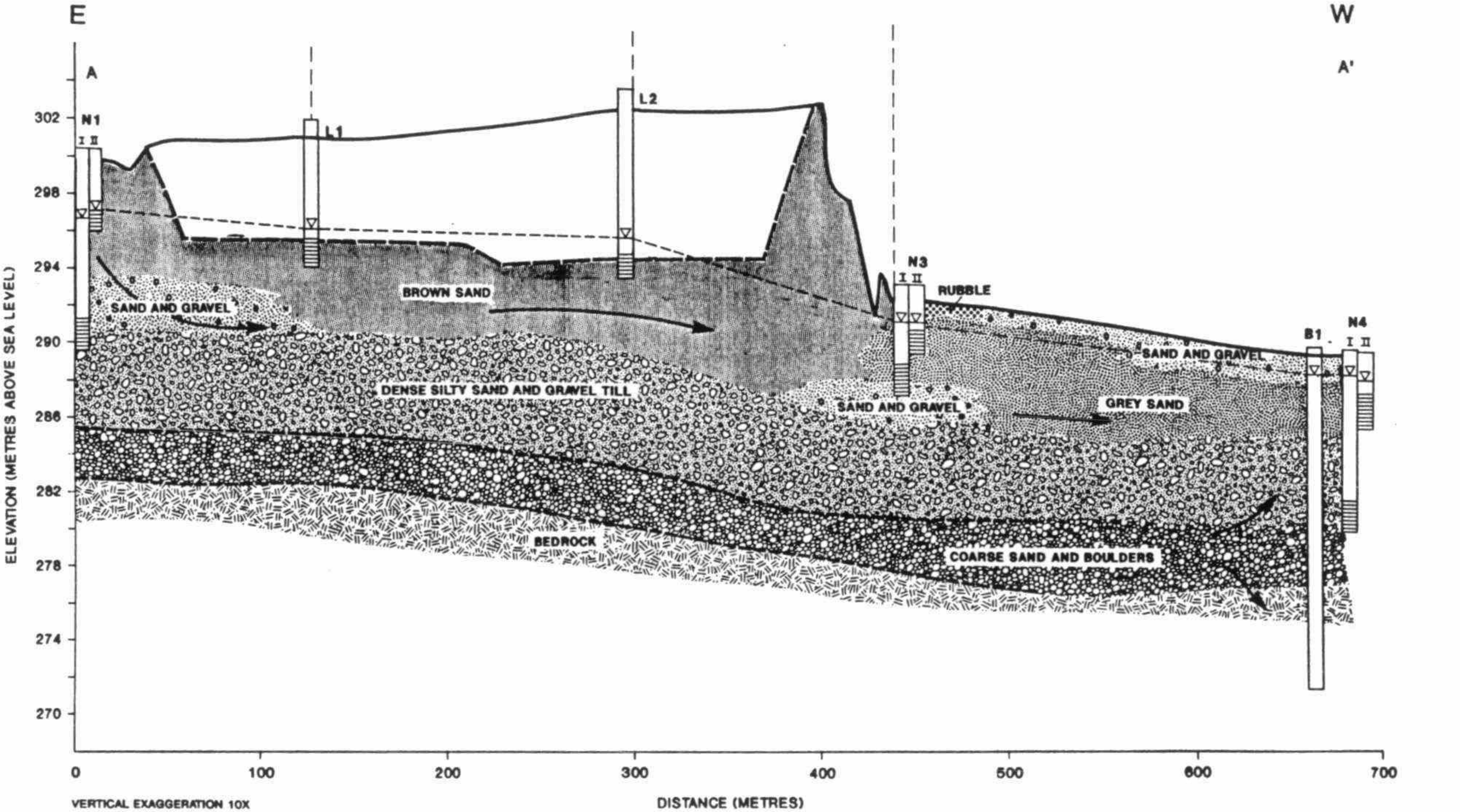
The classifications of the soil samples on the basis of grain size distribution are summarized in Table 1. Figure 4 is a geological cross-section showing the inferred relationship between the various stratigraphic units as derived from the logs of boreholes drilled on and around this site. The location of the cross-section is shown on Figure 3.

The landfill site is situated on kame deposits consisting of brown silty fine to coarse sand. Greater than 9.2 m of this sand is found on the east side of the landfill site (N2). These sediments also underlie the refuse.

Northeast of the landfill site, 6.1 metres of brown sand are found underlain by 1.8 m of coarse gravel. A dense silty sand and gravel till unit is found below the gravel.

Boreholes drilled along the western edge of the landfill site encountered 3 m of grey sand at a depth of 1.5 m. Gravel is also found beneath this sand.

The two boreholes located on the west side of Highway 24 penetrated 3.5 m of grey fine grained sand overlain by 1 m of sand and gravel. At this location, a very dense silty sand and gravel till unit 4.8 m thick, was encountered beneath the grey sand. This unit, although found below the water table, did not produce water during drilling. The till is underlain by 3.1 m of coarse sand, gravel and boulders (see Figure 4).



NEWTON LANDFILL SITE
Geological Cross Section A-A'

ALL STRATIGRAPHIC BOUNDARIES ARE INFERRED

→ GROUNDWATER FLOW DIRECTIONS (NOT TO SCALE)

FIGURE 4

TABLE 1
SUMMARY OF SOILS ANALYSIS
NEWTON LANDFILL SITE

Borehole	Sample Depth (m)	Soil Type	Inferred Deposit
N-1	4.5	Silty fine to coarse sand	Kame
N-1	9.1	Silty fine to coarse sand	Kame
N-2	4.5	Fine to coarse sand, little silt	Kame
N-3	4.5	Silty fine sand	Kame
N-4	6.0	Silty fine to coarse sand, gravelly	Till
N-4	9.1	Silty fine to coarse sand, gravelly	Glacio-Fluvial

The bedrock intersected in borehole B1 at a depth of 12.49 m consisted of grey dolomite. Bedrock topography maps indicate that the landfill is situated on a local bedrock high point.

The refuse was found to extend to depths of 5.5 m in borehole L1 and 8.2 m in borehole L2. This consisted predominantly of domestic waste such as cloth, rubber tires, paper, etc. In addition, concrete blocks and metal objects similar to car parts were encountered during drilling. The approximate areal extent of the refuse is shown on Figure 3.

As determined from hand auger holes, the cover material for the landfill consists of a fine grained sand. The thickness varies between 0.20 and 0.60 m.

The surficial material in the swampy low lying area is a black organic peat. The organic layer is approximately 0.8 m thick and is underlain by fine sand.

4.2 Site Hydrogeology

4.2.1 Gradients

$\frac{5.5}{270} = 0.02$

0.02 gradient to west

Water levels obtained from the monitors are shown in Table 2. The water table decreases 5.5 m in elevation from east to west across the site, a distance of approximately 270 m. East of, and beneath the site ground water flows westward under the influence of a hydraulic gradient in the order of of 0.01. At the western edge of the landfill, the water table drops sharply to the drainage channel, and seepage into the channel was observed at the toe of the slope. West of the landfill site, ground water continues its westward direction under a gradient of approximately 0.01.

Water levels in L1 and L2 do not indicate that the leachate is mounding in the refuse. There is only 0.41 metres of saturated refuse in the north cell (at L1) and 1.2 metres of saturated refuse in the south cell (at L2). The piezometric elevations in the leachate monitors are consistent with the east to west ground water flow.

Vertical gradients measured in the brown sand show that at the northeast corner of the site, a downward gradient of 0.027 exists. Along the west side of the site, there is very little vertical gradient and the monitors installed west of Highway 24 indicate an upward gradient of 0.044 between the coarse material found below the till and the grey sand. The piezometric elevations in the bedrock and overburden monitors

NEWTON LANDFILL SITE

GROUNDWATER ELEVATIONS

TABLE 2

MONITOR DESIGNATION		ELEVATION TOP OF PIPE (m.a.s.l.)	ELEVATION GROUND SURFACE (m.a.s.l.)	SCREENED DEPTHS BELOW SURFACE	JULY 22 1988 READING (m)	JULY 22 1988 ELEVATION (m.a.s.l.)	JULY 28 1988 READING (m)	JULY 28 1988 ELEVATION (m.a.s.l.)	AUG. 15 1988 READING (m)	AUG. 15 1988 ELEVATION (m.a.s.l.)	AUG. 31 1988 READING (m)	AUG. 31 1988 ELEVATION (m.a.s.l.)	SEPT 30 1988 READING (m)	SEPT 30 1988 ELEVATION (m.a.s.l.)
N-1	I	300.21	299.76	8.25-9.75	3.32	296.89	3.32	296.89	3.34	296.87	3.39	296.82	3.43	296.78
N-1	II	300.22		2.62-4.12	3.18	297.04	3.17	297.05	3.19	297.03	3.24	296.98	3.28	296.94
N-2		304.24	303.46	8.10-9.60	7.52	296.72	7.51	296.73	7.53	296.71	7.58	296.66	7.62	296.62
N-3	I	293.11	292.26	4.92-6.42	1.98	291.13	1.88	291.23	1.90	291.21	2.00	291.11	1.91	291.20
N-3	II	293.11		2.10-3.60	1.99	291.12	1.88	291.23	1.90	291.21	2.02	291.09	1.92	291.19
N-4	I	290.23	290.04	7.60-9.10	1.78	288.45	1.42	288.81	1.38	288.85	1.58	288.65	1.52	288.71
N-4	II	290.19		2.28-3.78	1.89	288.30	1.64	288.55	1.60	288.59	1.82	288.37	1.71	288.48
L1		301.50	300.84	5.51-7.01	6.72	294.78	5.66	295.84	5.69	295.81	5.70	295.80	5.73	295.77
L2		303.28	302.29	7.60-9.10	7.98	295.30	7.95	295.33	7.95	295.33	7.98	295.30	8.00	295.28
B1		290.21	290.06	18.28			1.40	288.81	1.39	288.82			1.80	288.41

west of Highway 24 indicate a downward gradient of 0.033 between the coarse overburden and the bedrock. These gradients suggest that the ground water in the deep overburden aquifer is under confined conditions. Based on the gradients observed at the site, ground water flow directions are schematically illustrated on Figure 4.

4.2.2 Hydraulic Conductivities

Bulk hydraulic conductivities were calculated from the grain size distribution curves (Appendix D) using Hazen's formula, and from the rising head test data (Appendix E) using Hvorslev's (1951) equations. The results are shown in Table 3. The calculated hydraulic conductivity of 6.8 x 10^{-8} m/s in the grey sand at monitor N4II is anomolous. The reason for this low value is not known, however it may be that the monitor was not sufficiently developed prior to testing. On the basis of observation of the samples, it is concluded that this value is not representative of the stratigraphic unit.

Based on the limited data available, the ranges and geometric means of hydraulic conductivities in the various units tested are also shown on Table 3.

A pump test conducted in the bedrock monitor located west of Highway 24 resulted in an immediate hydraulic response in the coarse sand and gravel deposit overlying the bedrock. This suggests that the bedrock and the overlying sand and gravel are hydraulically connected. This bedrock/overburden combination has an estimated transmissivity of 23 m^2/day. The coarse sand and gravel has an estimated hydraulic conductivity of 1.6 x 10^{-5} m/s.

TABLE 3
SUMMARY OF HYDRAULIC CONDUCTIVITIES
NEWTON LANDFILL SITE

Monitor	Depth (m)	HYDRUALIC CONDUCTIVITY Rising Head Test (m/s)	HYDRUALIC CONDUCTIVITY Hazen (m/s)	Unit
N-1 I	8.3 - 9.8	2.3 x 10x^{-5}		Silty Sand Till
II	2.6 - 4.1	5.1 x 10^{-6}		Brown Sand
N-2	8.1 - 9.6	>1 x 10^{-4}		Brown Sand
N-3 I	4.9 - 6.4	7.3 x 10^{-5}		Sand & Gravel
II	2.1 - 3.6	1.2 x 10^{-5}		Grey Sand
N-4 I	7.6 - 9.1	2.1 x 10^{-5}		Sand & Gravel
II	2.3 - 3.8	6.8 x 10^{-8}		Grey Sand
N-1	4.5		4 x 10^{-6}	Brown Sand
N-1	9.1		1 x 10^{-6}	Silty Sand Till
N-2	4.5		5.6 x 10^{-5}	Brown Sand
N-3	4.5		1.2 x 10^{-5}	Sand & Gravel
N-4	6.1		1.6 x 10^{-7}	Silty Sandy Till
N-4	9.1		4 x 10^{-6}	Sand & Gravel

Unit	Range (m/s)	Geometric Mean (m/s)
Brown Sand	>1 x 10^{-4} - 4 x 10^{-6}	Approx. 2 x 10^{-5}
Grey Sand	1.2 x 10^{-5}	1.2 x 10^{-5}
Silty Sand Till	2.3 x 10^{-5} - 1.6 x 10^{-7}	1.5 x 10^{-6}
Sand & Gravel	7.3 x 10^{-5} - 4 x 10^{-6}	1.6 x 10^{-5}

4.2.3 Ground Water Velocities

Using assumed porosities of 0.35 for the sand units and 0.25 for the till, and the gradients and hydraulic conductivities discussed in the previous sections, ground water velocities can be estimated using Darcy's equation:

$$v = \frac{Ki}{n}$$

Where: v = average linear velocity (m/s)
K = hydraulic conductivity (m/s)
i = hydraulic gradient
n = porosity

The horizontal ground water velocity in the shallow brown and grey sand beneath and west of the site is estimated to be in the order of 15 to 25 m/yr westward. In the underlying silty sand till, the westward velocity is estimated to be approximately 2 m/yr, or one order of magnitude, lower.

At monitor N1 east of the site, a downward velocity in the brown sand of about 50 m/yr (0.14 m/day) is estimated.

4.3 Surface Water Flow

A spring surfaces at the base of the kame and esker deposits along the northern boundary of the landfill site. The natural drainage direction for this surface water is due

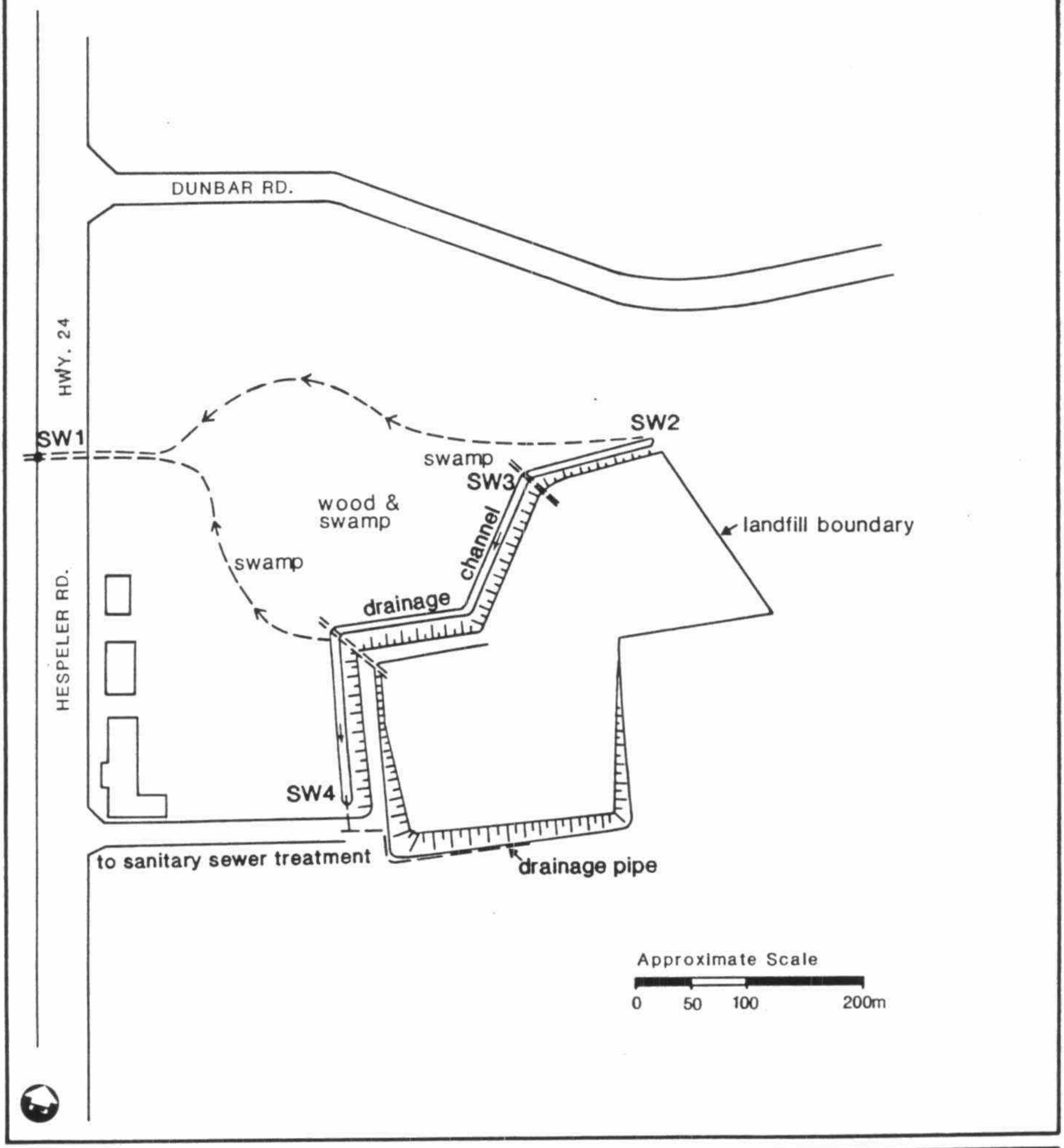
westward to the swampy area at the northwest corner of the property. Surface drainage from the top of the landfill is also directed to this area through two conduits on the northern slope (Figure 5). From here the flow is northwestward, through a culvert beneath Highway 24, to a small pond south of Dunbar Road.

There is a man-made drainage channel along the toe of the north and west slopes of the landfill, which collects leachate from surface seepage and shallow ground water flow. The channel drains by gravity into a manhole at the southwest corner of the site, which in turn feeds into the municipal sanitary sewer. Some of the water from the natural spring is also collected in the drainage channel.

In several places, the surface water in the swampy area beyond the drainage channel was observed to be discoloured and had a hydrocarbon sheen on its surface, similar to that of the surface water in the drainage channel. It has been reported (MOE files) that on several occassions in the past, the drainage channel has backed up and leachate has overflowed into the swampy area. Recently, regular maintenance by the City of Cambridge has prevented such overflow.

4.4 Methane Gas

The methodology and protocol for the methane gas study are described in Appendix B. The gas meter used on-site detects total combustible gas. However, in the absence of other apparent gas sources, and as a conservative approach, the total combustibles were assumed to comprise only methane. The gas meter used on-site will detect methane gas up to concentrations of 15,800 ppm.



NEWTON LANDFILL SITE

SW1 SURFACE WATER SAMPLE LOCATION

→ NATURAL SURFACE WATER FLOW DIRECTIONS

SURFACE WATER DRAINAGE PATTERN

Figure 5

DILLON

The results of the methane gas readings are shown in Table 4 and on Figure 6.

Methane gas in air is explosive only within a certain range of concentrations. The U.S. National Fire Protection Association (1978) has determined that the upper explosive limit (UEL) for methane gas is 150 000 ppm and the lower explosive limit (LEL) is 50 000 ppm. (5% — 15%)

The methane gas readings taken within the operational boundary of the landfill site show that methane gas is being produced. Readings in this area ranged between 442 ppm (0.9% LEL) and >15 800 ppm (>31% LEL).

Several of the readings indicate the presence of significant methane gas concentrations outside of the operational boundary of the landfill site. Of immediate concern are readings 31 and 32 (Figure 6) which show methane gas concentrations in excess of 15 800 ppm (31% LEL) only 25 m north of the new residences.

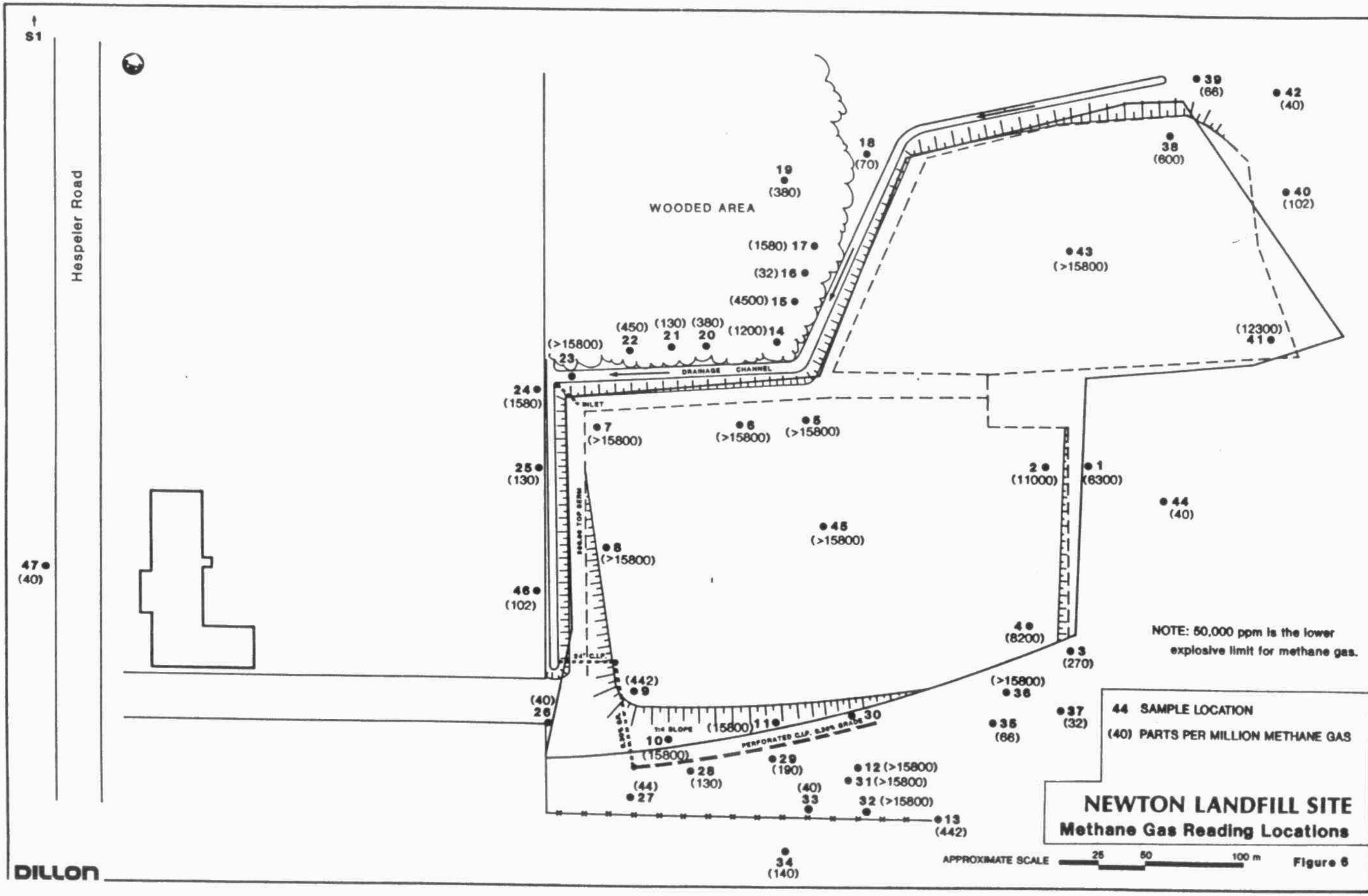
Readings 15 and 17 indicate methane gas concentrations of 9500 ppm (19% LEL) and 1580 ppm (3.1% LEL) respectively in the swampy area.

Reading 23 shows that the gas percolating through the sandy material in the drainage channel contains concentrations of methane greater than 15 800 ppm (31% LEL).

TABLE 4
METHANE GAS READINGS

Location	Methane (ppm)	% LEL*	Depth (m)
1	6 300	13	1.0
2	11 000	22	1.0
3	270	0.5	1.0
4	8 200	16	1.0
5	>15 800	>31	0.8
6	>15 000	>31	0.6
7	>15 800	>31	0.5
8	>15 800	>31	0.8
9	442	0.8	0.6
10	>15 800	>31	0.4
11	>15 800	>31	0.4
12	>15 800	>31	1.0
14	1 200	2.4	1.3
15	9 500	19	1.3
16	32	0.06	1.3
17	1 580	3.1	1.3
18	70	.1	1.3
19	380	0.7	1.3
20	380	0.7	0.4
21	130	0.2	0.5
22	450	0.8	0.80
23	>15 800	>31	Surface
24	1 580	3.1	0.40
25	130	0.2	0.30
26	40	0.08	1.00
27	44	0.08	1.00
28	130	0.2	1.00
29	190	0.42	1.00
30	220	0.44	1.00
31	>15 800	>31	1.00
32	>15 800	>31	1.00
33	40	0.08	1.00
34	140	0.28	1.00
35	66	0.13	1.00
36	>15 800	>31	0.60
37	32	0.06	0.80
38	600	1	0.80
39	66	0.1	0.80
40	102	0.2	1.20
41	12 300	25	1.20
42 (N1)	40	0.08	1.0 - 3.1
43 (L1)	>15 800	>31	1.0 - 3.1
44 (N2)	40	0.08	1.0 - 3.1
45 (L2)	>15 800	>31	1.0 - 3.1
46 (N3)	102	0.2	1.0 - 3.1
47 (N4)	40	0.08	1.0 - 3.1

*<u>Note</u>: The lower explosive limit (LEL) of methane gas is 50,000 ppm.



NEWTON LANDFILL SITE
Methane Gas Reading Locations

Figure 6

4.5 Water Quality

A total of 16 samples were submitted to the laboratories for analyses, comprising:

- eight (8) ground water, one from each monitor;
- four (4) surface water;
- two (2) leachate;
- one (1) field blank for QA/QC;
- one (1) duplicate sample for QA/QC.

The sampling locations are illustrated on Figure 3, and the sampling protocol is discussed in Appendix B.

Each sample was analyzed for a comprehensive suite of parameters, including:

- <u>General Chemistry</u>

Alkalinity	Field pH
Dissolved Organic Content	Field Specific Conductance
Ammonia	Field Temperature
Biochemical Oxygen Demand	Total Phenols

- <u>Major Ions</u>

Chloride	Bromide
Sulphate	Sodium
Nitrate	Potassium
Nitrite	Calcium
Fluoride	Magnesium

- Trace Metals

  18 Metals commonly associated with liquid and solid waste streams, including:

Iron	Copper
Arsenic	Lead
Cadmium	Zinc
Chromium	Mercury

In addition, to better characterize the leachate and identify parameters of particular concern, the leachate samples were analyzed for a comprehensive suite of organic parameters, including:

- Priority Pollutants

  The priority pollutant list comprises 56 base/neutral and acid extractable organic compounds from the EPA designated list of priority pollutants.

- Polychlorinated Biphenyls (PCB) Pesticides and Herbicides

  23 chlorinated pesticides and seven nitrogen phosphorous herbicides.

- Volatile Organic Carbon

  A suite of some 33 of the more common volatile organic carbon compounds.

The complete set of analytical data is included as Appendix F. Results of analyses for several of the inorganic parameters which best illustrate the character of the ground

water and leachate are summarized in Table 5. Results of surface water sample analyses for the same parameters are summarized in Table 6. Table 7 summarizes all the positive determinations of organic parameters in the leachate samples.

4.5.1 Leachate

The inorganic chemistry of the leachate at the Newton Landfill site is characterized most predominantly by elevated alkalinity and conductivity, as is typical of municipal landfill leachate. These elevated levels are caused largely by high concentrations of the major ions (most notably sodium, calcium and potassium). The leachate also contains significantly elevated concentrations of ammonia, iron and boron, and a pH (6.29 - 6.42) which is consistently lower than the surrounding ground water.

The concentration of sulphate in the leachate is below the detection limit (<0.50 ppm) which is a reflection of the anaerobic reducing conditions typical of landfill leachate.

The organic nature of the leachate is indicated by high concentrations of both BOD and COD. Specifically the leachate is characterized by the presence of BTX's (benzenes, toluene and xylenes) and four of the phenolic compounds (see Table 7).

Also detected were low concentrations of several phthalate esters which are ubiquitous both in landfills and in the environment in general. With the exception of 7.8 ppb of 1,4-dichlorobenzene in monitor L1, no chlorinated solvents

TABLE 5
NEWTON LANDFILL GROUND WATER INORGANIC CHEMISTRY

	GROUND WATER								LEACHATE		Drinking Water
	N1 II	N1 I	N2	N3 II	N3I	N4 II	N4 I	B1	L1	L2	Objectives
General Chemistry											
BOD	6.0	12.5	11.0	17.5	24	18	5.0	3.5	57	60	10***
DOC	1.8	2.3	1.4	19.8	7.2	9.3	2.1	1.9	122	186	5*
Phenols[2]	<.5	<.5	<.5	1.5	<.5	<5	5	1	100	380	2*
Ammonia (as N)	.03	.04	<.02	2.21	2.20	.17	.23	.16	45.2	25.5	0.5***
Alkalinity[1]	281	234	373	704	421	289	263	247	1320	1350	30-500*
Conductivity	687	597	976	1921	1016	1153	826	976	2522	2017	
Temp.	15	12	16	17	16	16	16	15	13	17	
pH	7.27	7.21	6.77	7.06	7.33	7.59	7.09	7.52	6.42	6.29	
Major Ions											
Chloride	12.7	5.85	24.4	176	65.2	200	60.8	73.3	32.2	79.5	250*
Fluoride	.18	.12	<.10	<.10	.30	<.10	.40	<.10	.30	.40	
Nitrite (as N)	.05	.05	.04	<.10	<.10	<.10	<.10	<.10	<.10	<.10	
Phosphate	<.10	<.10	<.10	<.10	<.10	<.10	<.10	<.10	<.10	<.10	
Sulphate	55.3	32.8	23.1	1.85	14.8	7.82	56.5	27.3	<.50	<.50	500*
Nitrate (as N)	.23	.46	1.88	<.01	<.01	<.01	<.01	<.01	<.10	<.10	10*
Potassium	2.6	2.1	1.0	32.3	14.0	7.7	2.4	7.0	27.3	53.0	
Magnesium	27.4	27.6	27.5	42.4	35.9	41.6	33.3	26.2	32.1	38.2	150***
Sodium	34.1	8.1	4.8	94.5	45.4	96.0	17.9	31.0	332	97.9	20**
Calcium	80.2	71.6	117	119	77.3	60.5	96.5	89	205	276	75***
Metals											
Boron	.036	.022	.015	.555	.207	.114	.027	.019	.532	7.17	5**
Iron	.30	.10	.18	8.32	2.44	.13	.67	1.18	.32	91.5	0.3*
Arsenic[2]	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	50**
Mercury[2]	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	.06	.16	1**
Manganese	.51	.18	.06	1.21	.10	.02	.11	.06	1.22	0.69	.05*

[1] ppm $CaCO_3$
[2] ppb

Note: All values given in mg/L unless noted otherwise.

Drinking Water Objectives

- * Maximum Desirable Concentration based on aesthetics (MOE, 1983)
- ** Maximum Acceptable Concentration based on health (MOE, 1983)
- *** Health and Welfare Canada, 1987

TABLE 6
NEWTON LANDFILL SURFACE WATER CHEMISTRY

	SW1	SW2	SW3	SW4	Drinking Water Objectives
General Chemistry					
BOD	9.8	12.5	24.0	49.0	10***
DOC	7.1	8.3	12.4	47.8	5*
Phenols[2]	>.5	.5	1.5	70.0	2*
Ammonia (as N)	.66	.03	24.6	21.7	.5***
Alkalinity[1]	494	385	462	644	30-500*
Conductivity	1480	700	1008	1380	
Temp.	21°C	19	17	20	
pH	7.19	6.80	6.79	7.04	
Major Ions					
Chloride	149	4.92	41.8	56.1	250*
Fluoride	.14	<.01	<.01	<.01	
Nitrite (as N)	<.01	<.01	<.01	<.01	
Phosphate	<.1	<.1	<.1	<.1	
Nitrate (as N)	.41	<.01	1.26	<.01	10**
Sulphate	19.3	4.15	25.0	12.8	500*
Potassium	12.2	.5	11.4	18.1	
Sodium	125	2.5	24.8	40.0	20**
Calcium	130	143	133	162	75***
Metals					
Iron	2.45	11.6	35.9	11.5	.3*
Mercury[2]	.12	.05	<.05	<.05	1**
Boron	.106	.025	.192	.450	5**
Manganese	.57	.65	.35	.21	.05*

[1] ppm $CaCO_3$
[2] ppb

Note: All values given in mg/L unless noted otherwise.

Drinking Water Objectives

* Maximum Desirable Concentration based on aesthetics (MOE, 1983)
** Maximum Acceptable Concentration based on health (MOE, 1983)
*** Health and Welfare Canada, 1987

TABLE 7
LEACHATE ORGANIC CHEMISTRY

	L1	(Duplicate)	L2
Base/Neutral Compounds			
1,4 Dichlorobenzene	7.83	(7.5)	-
Naphthalene	13.8	(13.4)	-
Diethyl Phthalate	19.8	(18.3)	309
Di-N-Butyl Phthalate	Tr	(Tr)	-
Bis-2-ethyl Hexyl Phthalate	6.6	(2.0)	151
Phenolic Compounds			
Phenol	-	(-)	353
O-Cresol	29.9	(20.3)	319
P-Cresol/M-Cresol	171	(168)	1870
2,4-Dichloro Phenol	3.4	(3.0)	-
Volatile Organics			
Chloroform	78	(-)	
Benzene	45.24	(-)	60.20
Toluene	64.25	(74.36)	7330
Ethyl Benzene	482.39	(284.09)	117.87
P&M Xylene	1060	(611.51)	247.64
O Xylene	624.59	(330.47)	165.44
Other Compounds Detected			
Tetrahydrofuran	62.40		35.51
Methyl Pentanone	73.39		-
Total C3-Benzenes	614.03		-
Total C4-Benzenes	285.27		-
Total Ketones	-		340.78

Note: Values reported in parts per billion (ppb).

tr - Trace
\- - Not detected

were detected, and with the exception of 13.8 ppb of napthalene, no polynuclear aromatic hydrocarbons (PAHs) were detected. No organo-chlorine or organo-phosphorous pesticides (including PCB) were detected in either leachate sample.

Generally, on the basis of the two samples obtained, the leachate appears to be typical of a low to medium strength municipal landfill leachate. The BTX and phenolic compounds detected, while not necessarily indicative of domestic refuse, are common to most municipal landfills.

4.5.2 Ground Water

The samples obtained from upgradient monitors N1I and N1II appear to be representative of natural ground water quality. The variance in ionic composition of the two samples (typically greater ionic strength in the shallow sample) is likely a reflection of the different stratigraphic units being sampled. In samples from these monitors, only the concentration of manganese exceeds the drinking water qualty criteria of 0.05 mg/l established by the Ministry of the Environment (MOE, 1983) on the basis of aesthetics (taste). The concentrations measured are not, however, atypical of ground water quality.

The chemical character of the sample from monitor N2 is slightly different than that of samples from N1I and N1II, with higher alkalinity, specific conductance, chloride and calcium, and lower sodium and sulphate concentrations.

However, ground water elevations measured at N2, L1 and L2 indicate that N2 is also upgradient of the landfill, and the quality variation may also reflect the different geological environment from which the sample was obtained.

The ground water immediately downgradient and west of the site shows definite influence of the landfill. Relative to back ground quality, samples N3I and N3II, collected from 8 m to 2 m depth respectively, contain elevated values of BOD, DOC, phenols, ammonia, alkalinity, specific conductance, chloride, boron, iron, potassium and magnesium. For the majority of these parameters the concentrations tend to decrease with depth. Conversly, sulphate concentrations which are lower than background increase with depth. The proximity of these monitors to the landfill site suggests that the elevated concentrations can be solely attributed to landfill leachate.

The sample obtained from the shallow monitor (N4II) located west of Highway 24 also appears to be somewhat contaminated. The concentrations of BOD, DOC, specific conductivity, chloride, boron, magnesium and sodium are all significantly higher than background, and that of sulphate is lower.

The bedrock sample (B1) and deep overburden sample (N4I) west of Highway 24 have chemistries similar to each other and to background ground water quality. Specific conductance, chlorides and iron are higher than background, however this may be attributed to influences from the bedrock where in general, these parameters have higher concentrations. Phenols were found in both of these wells.

4.5.3 Surface Water

The analytical results from the surface water samples are summarized in Table 6.

Sample SW2 obtained in the marsh from the northeast corner of the landfill has a chemistry similar to the background ground water. The differences such as DOC, phenols and temperature are likely due to the marsh type environment. The high iron concentration of 11.6 mg/L may be attributed to metallic objects thrown into the marsh. Samples SW3 and SW4 depict the degradation of surface water as it travels along the landfill site boundary in the drainage channel. The influence of leachate contamination is evident in practically every parameter, but most notably in phenols, ammonia, chlorides, boron and iron.

In March 1977, a grab sample collected from the leachate collection system was analyzed by the City of Cambridge Engineering Department Laboratory (see Appendix A). In July, 1987, leachate samples were also collected from the drainage channel (exact locations not known) by the MOE for analyses (Appendix A). In Table 8, the concentrations of parameters common to all the sampling events are compared to those in the recent sample from SW4.

A significant reduction in the concentrations of BOD, COD, iron and chloride is evident. This is likely an indication of the decay of the strength of leachate at the source over ten years.

TABLE 8

COMPARISON OF WATER QUALITY IN DRAINAGE CHANNEL OVER TIME

	SAMPLE AND DATE						
Parameter	City 28/03/77	MOE 1 16/07/87	MOE 2 16/07/87	MOE 3 16/07/87	MOE 4 16/07/87	MOE 5 16/07/87	SW4 30/09/88
BOD	990	52.2	71.4	67.8	66.8	-	49
COD	1870	82	128	50	118	38	
Alkalinity	440	652	552	584	552	620	644
Iron	46	13.0	7.6	18.0	13.0	-	11.5
Ammonia (as N)	29.7	20.8	19.3	16.8	17.7	17.4	21.7
Nitrate (as N)	3	.10	.15	.05	.05	.15	<.01
Nitrite (as N)	.054	<.005	<.005	<.005	<.005	.045	<.01
Chloride	108	60.8	50.5	48.6	47.9	49.8	56.1

All results expressed in mg/l

The analyses conducted by the MOE on one sample of the surface water in the drainage channel included volatile organics. Positive determinations are summarized in Table 9.

Six of the ten parameters in Table 9 are the same as those identified in monitors L1 and L2, which suggests that in addition to the off-site migration of inorganic contaminants identified in ground water, off-site organic migration is also likely occurring in the shallow ground water.

Sample SW1 obtained on the west side of Highway 24, approximately 100 m south of Dunbar Road was found to have several parameters with concentrations not representative of background conditions. Specific conductance, chlorides, sodium and mercury are higher than surface waters adjacent to the landfill in the drainage channel.

TABLE 9
POSITIVE ORGANIC DETERMINATIONS - MOE 1987 SURFACE WATER SAMPLE

Parameter	Concentration	Drinking Water Objectives*	Parameter	Concentration	Drinking Water Objectives*
• dichloromethane	13	50	• ethylbenzene	3	2.4
• 1,1-dichloroethane	33	-	• p&M-xylenes	37	300
• 1,1,1-trichloroethane	2	-	• x-xylene	22	-
• benzene	3	5	• 1,4-dichlorobenzene	2	5
• toluene	86	24	• 1,2-dichlorobenzene	3	200

* Health and Welfare Canada (1987)
** Total xylenes
All values reported as ppb

4.6 Leachate Generation

Leachate generation occurs at landfill sites through two processes. Firstly, precipitation infiltrating through the landfill cover will leach contaminants from the refuse and unless intercepted by an impermeable layer, travel to the ground water. Secondly, natural ground water flowing laterally through the refuse will leach contaminants from the refuse.

Leachate production resulting from precipitation can be estimated by the following equation:

$$Lp = (1-R)(P-E)A$$

Where: LP = volume of leachate produced (m^3/day)
P = precipitation (m/day)
E = evaportranspiration (m/day)
R = runoff coefficient
A = area of landfill (m^2)

This region receives approximately 900 mm of precipitation annually, of which approximately 580 mm is lost through evapotranspiration, leaving 320 mm of available water for runoff and infiltration. As an approximation, a runoff coefficient of 0.1 is suggested for sandy soils with an average slope of 2-7% (Viessman et al. (1977). The area of the landfill is approximately 50,000 m^3. Thus the volume of leachate produced by infiltration, based on a yearly average is in the order of 40 m^3/day.

Another estimate of infiltration was obtained using the Hydrologic Evaluation of Landfill Performance Model (HELP).

This model determines the volume of infiltrating precipitation based on daily precipitation rates, vegetative cover, soil type, monthly temperature data and solar radiation data. A printout of this data is found in Appendix G. The HELP model predicted 52 percent of the rainfall would infiltrate the waste. This results in a production of approximately 65 m^3 of leachate per day. We suggest that this is a conservatively high estimate.

Leachate generation by ground water flow can be estimated by:

$$Lg = v \times T \times W$$

Where: v = average linear velocity (m/day)
T = saturated thickness of refuse (m)
W = width of landfill (m)

Using a ground water velocity of .055 m/day (20 m/yr), an average saturated thickness of 0.80 m and a landfill width of 220 m, some 10 m^3 of leachate will be produced daily by lateral ground water flow.

Based on these calculations the total leachate generation rate is estimated to range between 50 and 75 m^3 per day (7.6 - 11.47 igpm).

Although the flow rate in the drainage channel was not measured, it was estimated by observation at the manhole during the field program to be in the order of 32-52 m^3/day (5 - 9 igpm).

4.7 Vegetation Assessment

The landfill is capped with a mixture of herbaceous species including grasses, goldenrod, St. Johnswort and sweet clover. The landfill cap vegetation appears to be affected by soil infertility and dryness.

Poplars and willows have become established in the northern part and a variety of woody species are found around the edges including black locust, manitoba maple, sumac and glossy buckthorn. Of particular note are vigorous young black walnut, basswood, bur oak and white ash on middle slope positions of the northwestern banks. Another interesting small specimen is an apricot on the west side.

Leachate is evident along the northwestern drainage ditch. Leachate damage to vegetation appears to be limited to the waterside herbaceous growth. Leaf browning of raspberries on the bank slope is probably related to drought stress.

Construction of a berm northwest of the ditch has stopped leachate from flowing into the treed swamp to the northwest but has also damaged some trees along the edge. A muskrat was seen using the drainage ditch between the berm and the landfill.

A young community of trembling aspen and larch is located west of the drainage ditch. A mature deciduous woodlot of considerable richness and diversity occurs south of the landfill. Species include sugar maple, red maple, red oak, white oak, bur oak, beech, white ash, black cherry, shagbark hickory, black walnut, white pine and yellow birch. An opening has been cut in the centre and tree trunks left on the ground. A small pond covered with pondweed is found west of the woodlot.

Other than in the immediate vicinity of the drainage channel, the landfill has had no readily apparent adverse impact on the surrounding vegetation.

5. IMPACT ASSESSMENT

5.1 Ground Water

The landfill site has had a significant impact on ground water quality. Leachate produced by infiltration through a highly permeable cover, and by lateral ground water flow, has migrated beyond the property boundaries, and continues to do so at an estimated horizontal velocity of 15-25 m/yr. In the 20 years since landfilling began at the site, it is possible that conservative (non-reactive) constituents of leachate may have migrated as far as 500 m to the west.

There is conclusive evidence of ground water contamination by leachate in both the shallow (3.6 m) and deep (6.4 m) monitors at station N3 immediately west of the landfill property. Several parameters, including BOD, DOC, alkalinity, ammonia, sodium and iron, exceed the drinking water quality guidelines established by MOE or Health and Welfare Canada, at one or both of the monitors. The elevated BOD and COD concentrations indicate significant organic contamination, however the nature of the individual organic constituents are not known. The leachate characterization and the surface water analysis done by the MOE in 1987 suggest the primary components would be the BTX and phenolic compounds, with perhaps lesser concentrations of chlorinated solvents.

There is also evidence of contamination in the shallow ground water at monitor N4II, some 240 m west of the site. Concentrations of ammonia, chloride, sodium, BOD and DOC are all elevated above background, with the latter three parameters exceeding drinking water quality criteria. Although ground water velocities support the premise that

leachate contamination at this location is possible, the proximity of the monitor to Highway 24 casts uncertainty on the conclusion that the landfill is the source.

There is no evidence that downward ground water flow beneath the landfill has resulted in contamination of the bedrock or deep overburden aquifer. Boreholes N1 and B1 identified the presence of a dense silty sand till layer at depth. This unit has also been identified as a regional feature in an MOE report on the ground water resources in the Grand River Basin (MOE, 1980). In that report it is postulated that the till unit acts as a confining layer for the bedrock aquifer. Piezometric elevations measured at monitors N4I and B1 support this premise.

Furthermore, the chemical analyses of the sample from the bedrock monitor B1 showed no indication of contamination. It is therefore concluded that the landfill does not represent an immediate potential source of contamination to the municipal wells P6 and P7. However, the lateral continuity of the confining layer is uncertain and the radius of influence of the pumping wells is not known. Continued migration of leachate may ultimately affect the quality of water at the municipal wells.

To preclude long-term contamination of the municipal wells, consideration should be given to implementation of subsurface leachate control on the west side of the landfill.

Considering that an estimated 80% of leachate at the landfill is generated by infiltration, consideration should also be given to methods for leachate reduction, such as reducing the cover permeability and improving the grading.

5.2 Surface Water

The landfill site has a major impact on the surface water adjacent to it. The surface water results from ground water discharge to surface at the base of the kame deposits in the northeast corner of the site. Although this discharges is of relatively good quality at its source, the quality degrades along the base of the landfill site. The drainage channel intersepts some of the ground water discharge to surface and directs it southward to the sanitary sewer system.

West of the drainage channel, in the swampy area, the combination of the presence of methane gas, an observed hydrocarbon-like sheen and the inferred ground water hydraulics leads to the conclusion that some leachate is underflowing the drainage channel and discharging into this area.

The surface water sample obtained along the natural drainage path at Highway 24 does not show conclusive evidence of landfill site contamination. The sample contained concentrations of several parameters (chloride, mercury) higher than those observed in the leachate or the drainage channel, which suggests that contamination may be occurring from sources other than the landfill site.

5.3 Methane Gas

The Newton Landfill site is an active producer of methane gas at concentrations in excess of 15 800 ppm (>30% of the lower explosive concentration). The sampling program indicated significant lateral migration of methane to the south. Under frozen ground conditions, when vertical venting through the permeable sand is no longer possible, lateral migration will

accelerate. Therefore, the southward migration of methane represents a potential hazard to the newly developed residential area adjacent the site.

The City of Cambridge, recognizing this problem, has recently installed a passive venting system between the landfill and the houses. This system will be monitored throughout the winter to determine the lateral migration of methane gas under frozen ground conditions.

Methane migration in other directions from the site is less pronounced, and the current developments are at greater distances from the boundary. Therefore methane migration is not considered an immediate hazard in these directions. Nonetheless, as part of the on-going monitoring program, methane concentrations in the subsurface should be measured during the winter months on the north, east and west sides of the landfill for confirmation.

6. CONCLUSIONS

- Leachate from the Newton Landfill site has contaminated the shallow ground water immediately west of the landfill property boundary to a quality unsuitable for drinking.

- Ground water hydraulics at and beyond the landfill are such that migration of conservative leachate constituents in the shallow ground water to a distance of approximately 500 m to the west is possible, since the closure of the site in 1972.

- Several parameters, including BOD, DOC, conductivity, chloride, sodium and boron were identified at concentrations significantly above background, in the shallow ground water some 240 m west of the site.

- Observed stratigraphy, ground water chemistry and hydraulic heads support the concept that a layer of till, with a relatively low permeability, hydraulically separates the bedrock and deep overburden aquifer from the shallow flow system. Therefore contamination by leachate of water from municipal wells P6 and P7 is unlikely.

- Surface water in the drainage channel on the western side of the landfill, is contaminated by leachate. Surface water in the swampy area west of the drainage channel is likely contaminated to a much lesser extent by leachate-contaminated ground water discharging to surface.

- There is no conclusive evidence of leachate contamination in the surface water west of Highway 24. This suggests that the assimilative capacity of the swampy area is sufficient to handle current leachate loadings.

- The landfill is actively producing methane gas in hazardous concentrations. Lateral migration of the methane is predominantly southward towards the adjacent residential development. As such a potential health hazard exists to the occupants of the new residences.

- The City of Cambridge has initiated a methane gas monitoring program to assess the magnitude of methane gas migration towards the residential area.

7. RECOMMENDATIONS

- A methane monitoring program should be implemented at the landfill in coordination with the ongoing program developed by the City of Cambridge. The focus of this program should be on the southern side, to assess the efficiency of the existing passive venting system, and to provide forewarning of hazardous methane migration to the residences.

- Methane alarms should be installed in the basements of the residences adjacent the landfill.

- Consideration should be given to methods for reduction of leachate production by infiltration.

- Consideration should be given to installation of an engineered system on the western edge of the landfill to mitigate the current off-site migration of leachate in the shallow ground water.

- Monitoring wells N4I, N4II and B1 should each be sampled once for analysis of the organic parameters which characterize the landfill leachate, to confirm or refute leachate presence in N4II, and to confirm leachate absence in N4I and B1.

- The use of the drainage channel as a play ground for children should be strongly discouraged by improved fencing, sign-posting and public awareness.

- Considering our conclusion regarding municipal pumping wells P6 and P7, there should be future consideration of sampling these wells for organic parameters (volatiles, acid/base/neutral extractables).

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appendices

APPENDIX A
BACKGROUND MATERIALS

February 23rd, 1973

A-1401 (new)
A-140101(old)

Mr.K.Wilk, P.Eng., Approvals Engineer, Waste Management Branch, Toronto.

Mr.B.A.Creamer, P.Eng., Regional Engineer, Waste Management Branch, Hamilton.

REGIONAL MUNICIPALITY OF WATERLOO - former City of Galt disposal site.

This site previously owned by the City of Galt has become the responsibility of Regional Government since January 1st, 1973. Since last month, the City of Cambridge (Galt) no longer make use of this site and therefore when the certificate expires March 31st I have indicated that it be renewed showing the condition that the site no longer be used.

B.A.C.

:ip

WATERLOO COUNTY HEALTH UNIT

850 KING STREET WEST KITCHENER ONTARIO AREA 519 PHONE 744-7357

17 Cambridge Street, Galt, Ontario 621-6110

March 3,1971

Mr. B.A. Creamer, P. Eng.
Assistant Regional Engineer
Midwest Region
Department of Energy and
Resources Management
Waste Managment Branch
460 Main Street East
Hamilton, Ontario

Re: The Corporation of the City of Galt Sanitary Land Fill Site

Dear Mr. Creamer:

Further to your letter of February 26,1971 (file #A-1401) an inspection at the above mentioned site was made on March 2,1971. Much garbage and refuse was scattered around perimeter of site due to lack of recent cover. Front end loader starting to add cover at time of inspection. Burning of wood and brush was taking place at site. Two drainage pipes under berm carry a mixture of leachate and spring water from base of site to swampy area at west side of landfill site. This drainage system appears to nullify purpose of extensive sand berm in preventing pollution of adjacent swamp.

I have no comment regarding the Waste Management System.

Yours truly

Stewart G. Brown

Stewart G. Brown, C.P.H.I.(c)
Sr. Public Health Inspector

SGB/lmh

WASTE MANAGEMENT BRANCH
E. & R. M.
RECEIVED
MAR 4 1971
HAMILTON
MID-WESTERN REGION

(<18 mesh) which constituted the major proportion of the sample submitted. A lower rate of leaching can be expected for the coarser fragments because of the lesser surface area in contact with leaching solution.

FCD/mp

c.c. Mr. J. N. Bishop, Manager,
Inorganic Trace Contaminants Section.

Ontario

Ministry of the Environment

ONTARIO MINISTRY OF THE ENVIRONMENT
MAR 12 1975
INDUSTRIAL ABATEMENT CAMBRIDGE OFFICE

135 St. Clair Avenue West
Suite 100
Toronto Ontario
M4V 1P5

3031

March 4th, 1975.

MEMORANDUM:

TO: Mr. G. P. McDonald ,
P.O. Box 219,
Clyde Road,
Cambridge, Ontario.

FROM: F. C. Darcel, Sediment & Soils Laboratory Supervisor,
Inorganic Trace Contaminants Section.

RE: GALT MALLEABLE IRON FOUNDRY WASTE - AURORA LODGE LANDFILL SITE, WELLINGTON

Leaching tests were conducted on this material collected on November 25, 1974 and identified by the Laboratory as S-48-9. The procedure followed was to extract 1 gm. portions of 18 mesh fraction with 50 ml quantities of distilled water, 0.5 N sulfuric acid, and 1 N ammonium acetate, by shaking on a wrist-action shaker for 15 minutes to obtain some estimate of soluble toxic constituents. The extracts were analyzed for heavy metals.

It was evident that high concentrations of manganese (all of that present) could be extracted by dilute mineral acid conditions (0.5 N H_2SO_4 leachate). A large amount of iron was also extracted under these conditions. A significant quantity of iron was extracted even by distilled water.

Although the concentration of those heavy metals tested was relatively low in the water and ammonium acetate leachates, and the reaction was slightly basic (pH 7.7 to 7.8) it is suggested that if acidic conditions should develop by contact with other wastes at the site or even by rain water undesirable leaching of heavy metals could occur.

The material was also leached with sodium hydroxide to extract organics. The leachate was clear in colour, indicating minor quantities. A total organic carbon test could not be conducted because of interferences. No further work was done on organic contaminants as it was felt that heavy metals were a more serious problem

The leaching tests were conducted on the finer fraction

/.....

GALT MALLEABLE IRON FOUNDRY WASTE

HEAVY METAL CONCENTRATION

Zinc (Zn)	98 ug/g* dry weight
Copper (Cu)	75
Nickel (Ni)	34
Lead (Pb)	38
Cadmium (Cd)	1
Manganese (Mn)	3000, 4000

* equivalent to parts per million (ppm)

LEACHING TESTS

EXTRACT	WATER		0.5 SULPHURIC ACID 1st		2ndxxx		ACETATE 1st		2nd	
	mg/l	ug/g*	mg/l **	ug/g	mg/l	ug/g	mg/l	ug/g	mg/l	ug/g
Mn	.19	9.5	62.5 , 56.5	2975	17.0 , 20.3	932	.70	35	.48	24
Fe	8.34	4.7	90.5 , 83.0	4338	7.5 , 8.2	392	.67	33	.91	46
Zn	.11	5.5	2.39 , 2.75	128	.84 , 1.34	54	.27	13	.16	8
Cu	.04	2.0	1.56 , 1.53	77	.33 , .30	16	.40	20	.42	21
Ni	.02	1.0	1.27 , 1.09	59	.35 , .39	19	.94	2.0	.05	2.5
Cd	.04	2.0	.05 , .04	2.2	.84 , 1.34	54	<.02	<1.0	<.02	<1.0
Cr	<.04	2.0	1.61 , 1.41	75	.56 , .63	30	<.04	<2.0	<.04	<2.0

* ug/g - micrograms per gm (ppm) based on original material.

** Duplicate leaching tests with sulphuric acid

xxx Second extraction.

Ministry of the Environment

West Central Region

Centennial Plaza
140 Centennial Parkway North
Stoney Creek, Ontario, L8E 3H2
Telephone: (416) 561-7410

RECEIVED
MAY 18

January 8, 1976

MEMORANDUM

47

To : F. Iliffe
District Officer
Municipal & Private Abatement
Cambridge District Office

From : J. Viirland
Ground Water Evaluator
Technical Support

Subject : Old Galt Landfill Site
Highway ~~24 at Du~~nbar Road

The report submitted by the Regional Municipality of Waterloo concerning the effluent emanating from the abandoned landfill site near Highway 24 and Dunbar Road in Cambridge has been reviewed. The report does not indicate whether or not ground water is contaminated as a result of this landfill. Reviewing the water well records for wells in the area it was determined that there are three municipal wells down gradient from this landfill site. The closest well is the Preston No. 7 well which is only about 1/2 mile from the site. The other two wells are within a mile of the site and are the No. 6 and No. 4 wells belonging to Preston. All wells are near the watercourse which receives leachate from the landfill site. It is not known if there is any infiltration from the stream bed or below the landfill site to the bedrock aquifer which supplies the municipal wells. From the driller's log for the No. 7 well, the overburden is only 26 feet thick at the well site. This consists of 6 feet of top soil, 10 feet of sand and 10 feet of gravel. The static water level of the completed well was 23 feet below ground level in 1951. From the well log there appears to be no confining clay layer above the bedrock.

.....2

On January 5, 1976 Mr. R. Luhowy, Supervisor, Pollution Control Laboratory of the Regional Municipality of Waterloo was contacted. Mr. Luhowy was advised of the existence of the municipal wells within a short distance of the landfill site. It was suggested that Mr. Luhowy compare the analysis of the water of the No. 7 well together with the other wells and determine if the quality has deteriorated. A copy of the water well record was provided to Mr. Luhowy. Records for the other two wells are not available.

The movement of the contamination originating from the landfill site into the ground water system has not yet been determined. This would require additional test drilling and installation of multiple piezometers to establish the three dimensional ground water flow system at the location. The analysis of the ground water in the observation wells would then be required in order to determine whether or not leachate is entering the ground water. The sampling would be from different depths to establish the shape and extent of the leachate plume in the ground-water system. The Technical Support Section does not have the facilities or the funds to carry out such an investigation and drilling program.

Should be determined

The Regional Municipality of Waterloo should carefully monitor the water quality from all three wells down gradient from the landfill site to ensure that contaminated water is not entering the aquifer and municipal water supply system. It may also be that the leachate is confined only to the surface water if the stream bed has no hydraulic connection to the major aquifer. Also the local conditions at the landfill site could be such that a confining layer exists to prevent the downward flow of water to the bedrock unit. If this is the case, then any contamination would be limited to the surface watercourse.

J. Viirland

J. Viirland

JV/bj

xxxxxx 885-9500

April 1, 1977

RECEIVED
APR 4 1977
MUNICIPAL & PRIVATE ABATEMENT

The Corp. of the City of Cambridge
Administration Offices
55 Dickson Street - Box 669
Cambridge (G), Ontario
N1R 5W8

Att: Mr. Fabian Bandoni, P. Eng., Deputy Engineer

Re: Old Galt Sanitary Landfill
Highway #24, Cambridge

Dear Fabian:

I am enclosing for your information our latest analyses taken from the storm sewer and sanitary sewer runoff at the above site.

You will note there is now a considerable difference between that water which is entering the sanitary sewer through the leachate collection system and that going to the storm sewer from surface runoff.

I felt you would be interested in knowing that the funds spent by the City of Cambridge on this particular project have paid off through a substantial reduction in contaminant discharged to the water course in this area.

Thank you very much for your cooperation.

Yours very truly,

R. Luhowy

Ralph W. Luhowy, C.E.T.
Supervisor
Pollution Control

Encl.
RWL/nl

cc: G. H. Thompson, P. Eng., Environmental Control Engineer
cc: Frank Iliffe, Ministry of the Environment

COMPANY NAME AND LOCATION

Old Galt Landfill Site
Highway #24
Cambridge, Ontario

DATE March 28/77 LAB. NO. 3-114

ANALYSES

B.O.D.	<10	CU	N/D	TOTAL COLIFORM per 100 ml.	0/100 ml.
S.S.		CR	N/D	FECAL COLIFORM per 100 ml.	0/100 ml.
D.S.		NI	N/D	NH_3 AS N	.8
T.S.	890	ZN	.3	NO_2 AS N	.047
C.O.D.	70	CD	N/D	NO_3 AS N	5.6
pH AT LAB.	7.1	FE	4	SO_4	62
FREON SOLUBLES		CN^-		CL^-	290
HARDNESS AS $CaCO_3$		CONDUCTIVITY μMHOS		PO_4 AS P	
ALKALINITY AS $CaCO_3$	200	PHENOLS μg/1	6		

COMMENTS: ALL RESULTS EXPRESSED IN MG/L EXCEPT pH UNLESS NOTED.

Hand grab sample from storm runoff taken from storm outfall to pond at 1105 hrs. on March 21, 1977.

E. Gabis.

ENGINEERING DEPARTMENT - LABORATORY

COMPANY NAME AND LOCATION

Old Galt Landfill Site
Highway #24
Cambridge, Ontario

ATE March 28, 1977

LAB. NO. 3-115

ANALYSES

B.O.D.	990	Cu	N/D	TOTAL COLIFORM per 100 ml.	0/100 ml.
S.S.		Cr	N/D	FECAL COLIFORM per 100 ml.	0/100 ml.
D.S.		Ni	N/D	NH_3 AS N	29.7
T.S.	1,680	Zn	.1	NO_2 AS N	.054
C.O.D.	1,870	Cd	N/D	NO_3 AS N	3
pH AT LAB.	6.6	Fe	46	SO_4	12
FREON SOLUBLES		CN^-		Cl^-	108
HARDNESS AS $CaCO_3$		CONDUCTIVITY µMHOS		PO_4 AS P	
ALKALINITY AS $CaCO_3$	400	PHENOLS µg/l	190		

COMMENTS: ALL RESULTS EXPRESSED IN MG/L EXCEPT pH UNLESS NOTED.

Hand grab sample from sanitary sewer in leachate collection system taken at 1120 hrs. on March 21, 1977.

E. Jakis

Environment Ontario
FINAL REPORT

File Cambridge Landfill site

Page 1
Printed 19/08/87

Municipality/Project

Submission: W C C B 2 0 6

Sampling Date(s) J U L 1 6, 1 9 8 7

Program 0400221 LANDFILL WC REGN -MUNICIPAL
Agency 0101020102 CAMBRIDGE

Sampled by MCKNIGHT, R. Date Submitted: 16/07/87, Date Received: 21/07/87

Mail this copy to MCKNIGHT,R
MOE M&PA
P.O. BOX 219
CAMBRIDGE ONTARIO
M1R 5T8

Final reports to MCKNIGHT,R MOE M&PA Telephone: 519-653-1511

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
1	CODE NOT GIVEN	OLD GALT LFS LEACHATE	16/07/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	LW30-0001		LF30-0001	

TESTS REQUESTED: G+WCLFRC G+WCLFM

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
2	CODE NOT GIVEN	OLD GALT LFS LEACHATE	16/07/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	LW30-0002		LF30-0002	

TESTS REQUESTED: G+WCLFRC G+WCLFM

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
3	CODE NOT GIVEN	OLD GALT LFS LEACHATE	16/07/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	LW30-0003		LF30-0003	

TESTS REQUESTED: G+WCLFRC G+WCLFM

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
4	CODE NOT GIVEN	OLD GALT LFS LEACHATE	16/07/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	LW30-0004		LF30-0004	

TESTS REQUESTED: G+WCLFRC G+WCLFM

Sample Class: LF

Results

LANDFILL (LEACHATES) ITC

Inquiries at: J. PIMENTA/GEORGE WOOD 235-5845
Telephone: 416-235-5854

Field Sample	Sampling Location	Sampling Location Description / Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
1	CODE NOT GIVEN	OLD GALT LFS LEACHATE / NOT GIVEN	LF30-0001		16/07/87		5
2	CODE NOT GIVEN	OLD GALT LFS LEACHATE / NOT GIVEN	LF30-0002		16/07/87		5
3	CODE NOT GIVEN	OLD GALT LFS LEACHATE / NOT GIVEN	LF30-0003		16/07/87		5
4	CODE NOT GIVEN	OLD GALT LFS LEACHATE / NOT GIVEN	LF30-0004		16/07/87		5

Field Sample Number... / Test Description / Code, Units of Measure / Method	1 LF30-0001	2 LF30-0002	3 LF30-0003	4 LF30-0004
COPPER, UNF.TOTAL CUUT ,MG/L as Cu (Copper) 520AA0	<.005<	<.005<	<.005<	<.005<
NICKEL, UNF.TOTAL NIUT ,MG/L as Ni (Nickel) 520AA0	.010	.007	.012	.008
LEAD, UNF.TOTAL PBUT ,MG/L as Pb (Lead) 520AA0	<.015<	<.015<	<.015<	<.015<
ZINC, UNF.TOTAL ZNUT ,MG/L as Zn (Zinc) 520AA0	.018	.020	<.010<	.036
IRON, UNF.TOTAL FEUT ,MG/L as Fe (Iron) 520AA0	13.000	7.600	18.000	13.000
MANGANESE, UNF.TOTAL MNUT ,MG/L as Mn Manganese 520AA0	.680	.300	.380	.370
ALUMINUM, UNF.TOTAL ALUT ,No Units available	!BL	!BL	!BL	!BL
CADMIUM, UNF.TOTAL CDUT ,MG/L as Cd (Cadmium) 520AA0	<.0020<	<.0020<	<.0020<	<.0020<
CHROMIUM, UNF.TOTAL CRUT ,MG/L as Cr (Chromium) 520AA0	<.005<	<.005<	<.005<	<.005<

Sample Class: LW   Results

LEACHATE SAMPLES   WQ

Inquiries at: STELLA TRACY
Telephone: 416-235-5877

Field Sample	Sampling Location	Sampling Location Description / Sample Description		LAB Sample#	Remarks	Sampling Date	Time	Zone
1	CODE NOT GIVEN	OLD GALT LFS / NOT GIVEN	LEACHATE	LW30-0001		16/07/87		5
2	CODE NOT GIVEN	OLD GALT LFS / NOT GIVEN	LEACHATE	LW30-0002		16/07/87		5
3	CODE NOT GIVEN	OLD GALT LFS / NOT GIVEN	LEACHATE	LW30-0003		16/07/87		5
4	CODE NOT GIVEN	OLD GALT LFS / NOT GIVEN	LEACHATE	LW30-0004		16/07/87		5

Field Sample Number... / Test Description / Code, Units of Measure / Method	1 / LW30-0001	2 / LW30-0002	3 / LW30-0003	4 / LW30-0004
CONDUCTIVITY 25C / COND25,UMHO/CM at 25 D.CENT. / 004AB4	1269.0	1141.0	1169.0	1142.0
HARDNESS, TOTAL / HARDT ,MG/L as CACO3 / CALC01	435.0	377.0	402.0	403.0
ALKALINITY,TOTAL / ALKT ,MG/L as CACO3 / 003BT3	652.0	552.0	584.0	552.0
PH (-LOG(H+(CONCN))) / PH ,DIMENSIONLESS / 004AI4	6.89	7.05	7.08	6.99
CHLORIDE, UNF.REACTIVE / CLIDUR,MG/L as Cl- Chloride / 004AC1	60.80	50.50	48.60	47.90
RESIDUE,TOTAL / RST ,No Units available	!IS	!IS	!IS	!IS
RESIDUE,FILTRATE / RSF ,No Units available	!IS	!IS	!IS	!IS
RESIDUE, PARTICULATE / RSP ,No Units available	!IS	!IS	!IS	!IS
PHOSPHORUS, UNF.TOTAL / PPUT ,MG/L as P Phosphorus / 504BC2	.020<T	<.010<W	.020<T	<.010<W

Sample Class: LW

Results

LEACHATE SAMPLES WQ

Inquiries at: STELLA TRACY
Telephone: 416-235-5877

Field Sample Number... / Test Description / Code, Units of Measure / Method	1 LW30-0001	2 LW30-0002	3 LW30-0003	4 LW30-0004
PHOSPHATES, FRAC.REACT. PPO4FR,MG/L as P Phosphorus 103BC2	<.01<W	<.01<W	<.01<W	<.01<W
NITR'N,TOTAL KJELD,UNF.R NNTKUR,MG/L as N (Nitrogen) 004BC2	21.50	19.50	17.10	17.90
AMMONIUM,TOTL, FRAC.REAC NNHTFR,MG/L as N (Nitrogen) 103AC2	20.80	19.30	16.80	17.70
NITRATES,TOTL, FRAC.REAC NNOTFR,MG/L as N (Nitrogen) 102CC2	.10<T	.15<T	.05<T	.05<T
NITRITE, FRAC.REACT. NNO2FR,MG/L as N (Nitrogen) 102CC2	<.005<W	<.005<W	<.005<W	<.005<W
BOD, 5DAY ,TOTAL DEMAND BOD5 ,MG/L as O (Oxygen) 001AI2	52.2	71.4	67.8	66.8
CHEMICAL OXYGEN DEMAND COD ,MG/L as O (Oxygen) 002AC0	82.	128.	50.	118.
DISSOLVED ORGANIC CARBON DOC ,MG/L as C (Carbon) 102AC2	25.0	45.5	13.0	43.5
DISSOLVED INORGAN,CARBON DIC ,MG/L as C (Carbon) 102AC2	115.0	83.0	101.0	89.0

REMARK CODE EXPLANATIONS

RMK	DESCRIPTION
!BL	NO DATA: UNRELIABLE BLANK
!IS	NO DATA: INSUFFICIENT SAMPLE.
<	ACTUAL RESULT IS LESS THAN THE REPORTED VALUE
<T	THIS LOW MEASUREMENT IS TENTATIVE. FOR INFO ONLY
<W	"ZERO". VALUE REPORTED IS MIN. MEASURABLE AMOUNT

*** END OF REPORT ***

Sample Class: LW Results

LEACHATE SAMPLES WQ

Inquiries at: STELLA TRACY
Telephone: 416-235-5877

Field Sample	Sampling Location	Sampling Location Description / Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
#1	CODE NOT GIVEN	CAMBRIDGE LFS. LEACHATE	LW16-0005		10/04/87		5

Field Sample Number... Test Description Code, Units of Measure Method	#1 LW16-0005
CONDUCTIVITY 25C COND25, UMHO/CM at 25 D.CENT. 002BI2	1230.0
HARDNESS, TOTAL HARDT ,MG/L as CACO3 CALC01	534.0
ALKALINITY, TOTAL ALKT ,MG/L as CACO3 004AT6	620.0
PH (-LOG(H+(CONCN))) PH ,DIMENSIONLESS 003AI2	7.00
CHLORIDE, UNF.REACTIVE CLIDUR, MG/L as Cl- Chloride 004AC1	49.80
RESIDUE, TOTAL RST ,No Units available	!DI
RESIDUE, FILTRATE RSF ,No Units available	!DI
RESIDUE, PARTICULATE RSP ,No Units available	!DI
PHOSPHORUS, UNF.TOTAL PPUT ,MG/L as P Phosphorus 504BC2	.25

Sample Class: LW Results

LEACHATE SAMPLES WQ

Inquiries at: STELLA TRACY
Telephone: 416-235-5877

Field Sample Number... / Test Description / Code, Units of Measure / Method	#1 LW16-0005
PHOSPHATES, FRAC.REACT. / PPO4FR,MG/L as P Phosphorus / 103BC2	.02<T
NITR'N,TOTAL KJELD,UNF.R / NNTKUR,MG/L as N (Nitrogen) / 004BC2	89.0
AMMONIUM,TOTL, FRAC.REAC / NNHTFR,MG/L as N (Nitrogen) / 103AC2	17.40
NITRATES,TOTL, FRAC.REAC / NNOTFR,MG/L as N (Nitrogen) / 102CC2	.15<T
NITRITE, FRAC.REACT. / NNO2FR,MG/L as N (Nitrogen) / 102CC2	.045
BOD, 5DAY ,TOTAL DEMAND / BOD5 ,No Units available	!U
CHEMICAL OXYGEN DEMAND / COD ,MG/L as O (Oxygen) / 002AC0	38.
DISSOLVED ORGANIC CARBON / DOC ,MG/L as C (Carbon) / 102AC2	27.5
DISSOLVED INORGAN,CARBON / DIC ,MG/L as C (Carbon) / 102AC2	83.0

Sample Class: NS

Results

* No Suitable Sample *

Inquiries at: STELLA TRACY
Telephone:

Field Sample	Sampling Location	Sampling Location Description / Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
#1	CODE NOT GIVEN	CAMBRIDGE LFS. LEACHATE	NSS -		10/04/87		5

Field Sample Number...	#1
Test Description / Code, Units of Measure / Method	NSS -
IRON, UNF.TOTAL / FEUT ,No Units available	NSS

Sample Class: PL

LANDFILL ORGANICS

Results

Printed 10/07/87

Inquiries at: BOB GUTTERIDGE
Telephone: 416-235-5758

Field Sample	Sampling Location	Sampling Location Description / Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
#1	CODE NOT GIVEN	CAMBRIDGE LFS. LEACHATE	PL16-0011		10/04/87		5

Field Sample Number... / Test Description / Code, Units of Measure / Method	#1 / PL16-0011	
1,1-DICHLOROETHYLENE X111CY,UG/L Microgram/Litre POCODO	<1. <W	
DICHLOROMETHANE CH2CL2 X1DCLM,UG/L Microgram/Litre POCODO	13.	
TR-1,2-DICHLOROETHYLENE X1T12D,UG/L Microgram/Litre POCODO	<1. <W	
1,1-DICHLOROETHANE X111CE,UG/L Microgram/Litre POCODO	33.	
CHLOROFORM CHCL3 X1CHLO,UG/L Microgram/Litre POCODO	<1. <W	
1,1,1-TRICHLOROETHANE X1111T,UG/L Microgram/Litre POCODO	2. <T	
1,2-DICHLOROETHANE X112CE,UG/L Microgram/Litre POCODO	<1. <W	
CARB TETRACHLORIDE CCL4 X1CTET,UG/L Microgram/Litre POCODO	<1. <W	
BENZENE C6H6 B2BENZ,UG/L Microgram/Litre POCODO	3. <T	Aromatic hydrocarbons [illegible]

Sample Class: PL

Results

LANDFILL ORGANICS

Inquiries at: BOB GUTTERIDGE
Telephone: 416-235-5758

Field Sample Number... / Test Description / Code, Units of Measure / Method	#1 PL16-0011
1,2-DICHLOROPROPANE X112CP,No Units available	!NP
TRICHLOROETHYLENE C2HCL3 X1TRIC,UG/L Microgram/Litre POCODO	<1.<W
BROMODICHLOROMETHANE X1BDCM,UG/L Microgram/Litre POCODO	<1.<W
TOLUENE C7N8 B2TOLU,UG/L Microgram/Litre POCODO	86. hydrocarbon solvents.
1,1,2-TRICHLOROETHANE X1112T,UG/L Microgram/Litre POCODO	<1.<W
CHLORODIBROMOMETHANE X1CDBM,UG/L Microgram/Litre POCODO	<1.<W
TETRACHLOROETHYLENE X1TETR,UG/L Microgram/Litre POCODO	<1.<W
CHLOROBENZENE X2CBEN,UG/L Microgram/Litre POCODO	<1.<W
ETHYLBENZENE C8H10 B2EBNZ,UG/L Microgram/Litre POCODO	3.<T
M-, AND P-XYLENES B2MPXY,UG/L Microgram/Litre POCODO	37.
BROMOFORM X1BROM,UG/L Microgram/Litre POCODO	<1.<W
O-XYLENE C8H10 B2OXYL,UG/L Microgram/Litre POCODO	22.
1,1,2,2-TETRACHLOROETHAN X11122,UG/L Microgram/Litre POCODO	<1.<W
1,4-DICHLOROBENZENE X214CB,UG/L Microgram/Litre POCODO	2.<T
1,3-DICHLOROBENZENE X213CB,UG/L Microgram/Litre POCODO	<1.<W

Sample Class: PL

Results

LANDFILL ORGANICS

Inquiries at: BOB GUTTERIDGE
Telephone: 416-235-5758

Field Sample Number... / Test Description / Code, Units of Measure / Method	#1 PL16-0011					
1,2-DICHLOROBENZENE X212CB,UG/L Microgram/Litre POCODO	3.<T					

REMARK CODE EXPLANATIONS

RMK	DESCRIPTION
!DI	NO DATA: SAMPLE DISCARDED IN ERROR
!NP	NO DATA: NO APPROPRIATE PROCEDURE AVAILABLE.
!U	NO DATA: UNSUITABLE FOR ANALYSIS
<T	THIS LOW MEASUREMENT IS TENTATIVE. FOR INFO ONLY
<W	"ZERO". VALUE REPORTED IS MIN. MEASURABLE AMOUNT
NSS	NO SUITABLE SAMPLE

*** END OF REPORT ***

1.132.6

THE CORPORATION OF THE CITY OF CAMBRIDGE

SITE INVESTIGATION OF THE PROPOSED

DUNBAR ROAD INDUSTRIAL SITE

MAY 15, 17 and 28, 1979

Heath Survey Consultants (Canada) Limited
954 Leathorne Street
London, Ontario
N5Z 3M5

TELEPHONE: Area Code 519 686-6446

HEATH Survey Consultants (Canada) Ltd.

954 LEATHORNE STREET,
LONDON, ONTARIO N5Z 3M5
TELEPHONE: 519 - 686-6446

June 11, 1979

Mr. Fabian Bandoni, P. Eng.,
Director of Design and Construction
The City of Cambridge
55 Dickson Street
Cambridge, Ontario
N1R 5W8

Dear Mr. Bandoni:

This letter of transmittal confirms completion of site investigations at the proposed Dunbar Road Industrial site. The test program was assigned to experienced field consultants, Messrs. Gary Eade, Robert Ferguson, and Herbert Lucas under our project number 79-1085.

A previous report, dated May 10, 1977 discusses results found on this site at that time. The current field work was completed on May 15, 17, and 28, 1979. All results obtained are indicated on the enclosed plan, borehole logs and monitoring report. The results of the tests have been considered carefully and a set of recommendations is presented.

Mr. Bandoni, we appreciate this opportunity to assist you and the interests which you represent. In the event you would like to discuss this report further, we are available at your convenience.

Yours very truly

Mary Vanderhoeven / Per

Gary Houghton
Staff Engineer

GH/mv

cc: London
S. B. Eynon
Houghton

THE CORPORATION OF THE CITY OF CAMBRIDGE

SITE INVESTIGATION OF THE PROPOSED

DUNBAR ROAD INDUSTRIAL SITE

BY

HEATH SURVEY CONSULTANTS (CANADA), LIMITED

INTRODUCTION

This report covers site investigations completed at the proposed Dunbar Road Industrial Site in the City of Cambridge, Ontario. The primary objective of the test program was to determine if the proposed development adjacent to the site would be affected by methane gas migration. In addition, it was to be determined if present developed properties are being infiltrated by combustible landfill gases. A previous investigation was completed on this site and documented in a report forwarded to Mr. Norman Gamble, and dated May 7, 1979. The recommendations arising from this report indicated that the site was very active (significant methane production) and therefore extensive measures would have to be taken if buildings were to be constructed on the site. At that time all investigations were confined to the site itself. This report goes beyond the confines of the site and through the use of borehole and soil atmosphere tests investigates the possibility of methane migration.

OBJECTIVES

1. To conduct a shallow probe soil atmosphere test at points throughout and beyond the site.

2. To conduct representative soil borehole tests to determine the composition of underlying strata.

3. To conduct interior investigations of enclosed structures within a reasonable distance of the site. Considerable attention was given to those structures located along Highway No 24 (Hespeler Road).

4. To assess the site in terms of development and how such development may be affected by the landfill site.

5. To accumulate all data derived through field tests and observations and assemble such data in a report which shall include all plans, borehole logs and monitoring forms. This report shall discuss all aspects of the situation and put forward recommendations pertaining to future and present developments.

INSTRUMENTATION AND PROCEDURES

There were three types of tests performed on and near this site. The instrumentation and procedures used are outlined below.

1. Soil Atmosphere Test:

   Instruments used were the standard Heath plunger bar and a Davis D-15 gastester. The Heath plunger bar is a manual impact tool capable of producing a sample hole in the soil of ½" in diameter and up to 40" deep. The Davis D-15 gastester will detect combustible hydrocarbons in concentrations of 0-100% gas. For more precise readings in the lower range, the D-15 also has capability of full scale on 5% gas. This is also referred to as 100% L.E.L., the lower explosive limit of methane gas. The soil atmosphere tests are conducted by first placing a hole, then testing a sample of the soil atmosphere in the hole. This would be repeated on a regular grid basis throughout the site and results recorded on a plan of the area.

2. Interior Building Investigations:

   The instrument used was the Heath Detecto-Pak II (R). This instrument is highly sensitive and will detect hydrocarbon concentrations from 1 to 10,000 ppm (parts per million). It is necessary to use such a sensitive instrument as the concentration of gas infiltrating a building is typically lower than that found in the soil surrounding the foundation. Test points are chosen within the building of gas infiltration. This would include, floor cracks, wall cracks, floor drains

and any conduits such as sewer electrical or telephone. The results obtained are recorded on a standard monitoring form.

3. Borehole Tests:

The equipment used was the J.K.S. Winkie (vehicle mounted) power drilling unit. This drill is capable of drilling to considerable depths using a 3" solid stem auger. Test points are chosen after other soil atmosphere tests are completed and the site is visually assessed. A record of the material turned up by the augers is maintained and plotted on a borehole log.

RESULTS

The results of all tests are shown on the enclosed plan, borehole logs and monitoring form. Soil atmosphere tests revealed that although the site is still very active, there appeared to be little migration to the north and east of the site. It must be noted that it is anticipated there would be limited migration due to the absence of a frost cap at the time of the test program. Readings on the site ranged to a maximum of 50% gas with some localized areas of high readings as indicated on the map. Very significant readings of up to 75% gas were obtained in the area west of the site. A visual assessment of this area revealed that this part of the site was a former swamp. It is unlikely, particularly in light of the high water table, that these readings are a result of the landfill. It can be reasonably assumed that this gas is being produced by putrescible organic material at a shallow depth on the site. This material would be of a "peat" nature and consists of decaying swamp constituents. This was confirmed by two borehole tests which indicate high concentrations of peat in the upper six (6') feet of soil strata. The remainder of the boreholes (depths greater than 6') revealed deposits of an alluvial nature, being mostly fine grained sands. The gas readings obtained in these boreholes ranged up to 20% gas but were limited to the upper six feet.

The third borehole was placed in the depression north of the site. There was no organic material revealed during augering. It was, however, noticed that for some distance along the north edge of the site there was swamp like

growth. A reading of 4% L.E.L. was obtained near the top of the borehole. indicating there may be some migration from the site at this time, however, the gas concentration is very low. No gas was detected on the surface in this area.

The interior building inspection was conducted at six businesses along Hwy. No 24. Four of the buildings were found to have positive readings. The readings in one structure are likely attributable to gasoline, not methane, being spilled outside the building. The highest reading obtained was 5% L.E.L. in a floor crack at 269 Hespeler Road (Highway No. 24). A visual inspection of the building revealed little noticeable settlement.

There was a considerable amount of leachate leaving the site by means of the drainage channel. The presence of the leachate seemed to be responsible for a significant amount of vegetation death along its path. The path of the leachate was uncertain after it left the confines of the site.

RECOMMENDATIONS/CONCLUSIONS

1. The tests which have been conducted would indicate that there would be no landfill related problems in the development of the site to the north of the drainage channel, the depression area and the east of the site.

2. It is recommended that no enclosed structures or hard surfaced areas be permitted south of the drainage channel to the E. W. Expressway. The site is very active in methane production and would thus pose a potential hazard for any surface development.

3. It is recommended that leachate and methane control measures be designed if the area north of the drainage ditch is filled. There is evidence of significant volumes of leachate being released at the base of the landfill area and flowing in the drainage channel. This has apparently affected vegetation in the area. There is also the possibility of methane migration should the depression area be filled with soil to the level of the fill area. It is further recommended

that if this depression area is filled, that a dense material that is highly compacted, such as clay be used to make a berm.

4. It is recommended that all buildings designed for this area have certain safeguards to protect them against methane infiltration. To this end, all proposed building plans should be submitted to a firm experienced in methane control for their review and comments.

5. Any earthmoving or construction of foundations and utility trenches should be closely monitored for the presence of putrescible matter. When backfilling such excavations it is recommended that precautions be taken to prevent methane migration through material which is not properly compacted. Trench lining should also be utilized where considered appropriate.

The above recommendations apply to the designated landfill area and the areas to the north and east of the site to the enclosing roadways. The area to the west of the site is not proposed for further development, however, the area was investigated for the migration of landfill gases. It was found that the most significant problem in this area was the former swamp. The following additional recommendations apply to this area, which lies between Hwy No 24 and the landfill site.

6. It is recommended that the enclosed structures on Hwy 24 be placed on a regular monitoring program during the winter months. It is critical during this period as the presence of a frost cap prevents the gas from venting to the surface and causes horizontal migration. A once weekly test during the months of December to April inclusive is suggested.

7. It is recommended that immediate controls be instituted in the garage behind Kenebuc Galt Ltd. There is sufficient volume and concentration of methane adjacent to the foundation to present a possible explosive hazard. This structure is small and closed for long periods, during which time methane could infiltrate and accumulate within the structure.

8. It is recommended that the building inspection department be made aware of the situation which exists at 261 to 289 Hwy. No 24 (Hespeler Rd.) As this is a former swamp area the structures may be subject to differential settlement and therefore structural deficiencies. An inspection to confirm that these structures are competent should be considered.

9. It is recommended that the City of Cambridge Fire Department and the Regional office of Union Gas Limited be notified of the special problems which exist in this area. The possible explosive hazard could pose a danger during a fire situation. As well, the leakage detection equipment employed by Union Gas would detect the gases produced by the swamp area.

10. It is recommended that furture construction in the area west of Hwy. 24 between Dunbar Rd. and the E. W. Expressway be preceded by a soil test to determine if there is a swamp related problem. Such tests would consist of shallow probe soil atmosphere tests and deep augering to determine the composition of underlying strata.

11. It is recommended that future gas controls be considered for the structures located on Hwy No 24 between Dunbar Rd and the E. W. Expressway. An immediate remedial measure would consist of the application of a waterproof coating (such as 3M Scotch Clad) to seal all floor cracks. This coating would resist gas infiltration. A long term solution would be to install a ventilation system to remove soil gas or impermeable trench to prevent gas migration.

The following recommendation is put forward to be applied generally not only in the area which is the subject of this report, but any area within jurisdiction of the City of Cambridge.

12. It is recommended that contractors or others involved in the excavation or earth moving at construction sites be required to contact the City Engineer for the City of Cambridge should any organic matter be encountered. Such areas should be tested for the presence of soil

combustibles. If it is determined that a possible hazard situation exists, the working environment should be monitored to detect the accumulation of any combustible gases. If the deposits are extensive the building permit agreement and all preliminary soil tests should be reviewed.

SUMMARY

The soil tests confirm that there are no landfill related problems at the proposed construction area. In the event there is significant earthmoving or excavation the site should be visually reassessed to assure the recommendations are still valid. Of immediate concern is the swamp area as described in the report. The high concentrations adjacent to the buildings are significant and pose a potential danger.

The recommendations contained in this report should be carefully considered. to provide a safe development on this site.

Gary Houghton
Staff Engineer

CAMBRIDGE

HEATH SURVEY CONSULTANTS (CANADA) LIMITED

954 LEATHORNE ST., LONDON, ONTARIO, N5Z 3M5

GAS MONITORING REPORT FORM

DATE	TIME	ADDRESS	TYPE OF BUILDING	FLOOR DRAINS	CONDUITS	INTERIOR ATMOSPH.	FLOOR CRACKS	WALL CRACKS	OUTSIDE WALL	REMARKS
May 17-79		289 HESPELER RD. ROE-HOILES MOTORS	BUSINESS	100 PPM.	NEG	NEG	NEG	NEG	B.TEST NEG	GASOLINE IN FLOOR DRAIN IN GARAGE
May 17-79		277 HESPELER RD SAVE WAY MOTORS	BUSINESS	—	—	NEG	NEG	—	B.TEST POS.	BUILDING ON CEMENT BLOCKS 2' ABOVE GROUND
May 17-79		275 HESPELER RD V.W. CAR SALES	BUSINESS	50 PPM	NEG	NEG	10 PPM	NEG	B.TEST POS.	(SEE MAP)
May 17-79		269 HESPELER RD KENEBEC GALT LTD	BUSINESS	NEG	NEG	NEG	100 PPM	NEG	B.TEST POS.	READING FOUND FLOOR CRACK - S.E
May 17-79		269 HESPELER RD (STORAGE GARAGE AT REAR)	GARAGE	—	—	100 PPM	5 LEL	—	B. TEST POS.	READING FOUND IN FLOOR CRACK - E. WALL
May 17-79		261 HESPELER RD MITTEN INDUSTRIES GALT LTD	BUSINESS	NEG	NEG	NEG	NEG	NEG	B.TEST POS.	(SEE MAP)

ALL MANHOLES - CATCH BASINS IN FRONT OF THESE BUILDINGS ALONG THE EAST SIDE OF HESPELER RD WERE FOUND TO HAVE NO COMBUSTIBLE READING ON THIS DATE

INSPECTED BY: [signature]

CLIENT: Corporation of the City of Cambridge

PROJECT: 79-1085

LOCATION: Cambridge

METHOD: Solid Stem Auger

DIAMETER: 3"

DATE: May 17, 1979

BOREHOLE #1

DEPTH IN FT.	DESCRIPTION	METHANE CONC.	WATER LEVEL
2	Industrial waste with black coarse sand and cinders 0-3'	5% Gas	Water table was encountered at a depth of 4'
4	Black wet course sand with traces of peat 3'-6'	20% Gas	WT
6, 8	Medium brown fine sand 6'-9'		
10, 12	Light brown fine grain sand 9'-12'		
14	Light brown silty sand 12'-15'		
16, 18, 20, 22, 24	Borehole was terminated at a depth of 15' in a light brown silty sand		

HEATH

SURVEY CONSULTANTS, LTD.

954 Leathorne St., London, Ontario, Canada N5Z 3M5

Tel. 519-686-6446

CLIENT: Corporation of the City of Cambridge

METHOD: Solid Stem Auger

PROJECT: 79-1085

DIAMETER: 3"

LOCATION: Cambridge

DATE: May 17, 1979

BOREHOLE #2

DEPTH IN FT.	DESCRIPTION	METHANE CONC.	WATER LEVEL
2	Industrial waste with black course sand with cinders 0'-3'	20% Gas	Water table at a Depth of 6"
4 6	Dark brown course sand with peat 3'-6'		
8	Medium brown fine sand 6'-9'		
10 12 14	Light brown silty sand 9'-15'		
16 18 20 22 24	Borehole was terminated at a depth of 15' in a light brown silty sand.		

HEATH
SURVEY CONSULTANTS, LTD.
954 Leathorne St., London, Ontario, Canada N5Z 3M5
Tel. 519-686-6446

CLIENT: Corporation of the City of Cambridge

PROJECT: 79-1085

LOCATION: City of Cambridge

METHOD: Solid Stem Auger

DIAMETER: 3"

DATE: May 28, 1979

BOREHOLE #3

DEPTH IN FT.	DESCRIPTION	METHANE CONC.	WATER LEVEL
2	Grey brown silty sand fill 0-2.5'		
4	Grey black silty sand 2.5' - 5'	4% L.E.L.	
6 8 10 12 14 16 18	Yellow brown clayey sand 5' - 18'		Water table was encountered at a depth of 10' at the time of drilling WT
20 22 24	Borehole was teminated at a depth of 18' in a yellow brown clayey sand		

Consultant: R. J. Ferguson

HEATH
SURVEY CONSULTANTS, LTD.
954 Leathorne St., London, Ontario, Canada N6Z 3M!
Tel. 519-686-6446

APPENDIX B
FIELD PROGRAM METHODOLOGY AND PROTOCOLS

B.1 Drilling Program

Prior to the commencement of the drilling program, an intensive site reconnaissance was conducted so that site specific details, such as leachate springs could be located and mapped. Following this, potential drilling sites were located and prepared so that each site would be accessible by the drilling rig.

The on-site drilling program was initiated on 19 July 1988 and completed 22 July 1988. A total of 10 monitors were installed: seven installations (N1-N4) into the shallow sand overburden, one deep installation (B1) to bedrock and two installations (L1-L2) into the refuse. Well logs and installation specifications are included in Appendix C. The installation locations can be observed on Figure 3.

The monitors were installed using a track-mounted Mobile B61 power auger drill with 170 mm inside diameter (I.D.) augers. The augers and drill bits were washed with City-supplied water by use of a mobile pressure washer. During the drilling of the leachate installations, a supply of full air and protective clothing were used. Badges were worn to detect the presence of tolylene diisocyanate.

B.2 Ground Water and Leachate Monitors

The monitors are constructed of Class 1, Grade 1, 50 mm diameter, flush threaded Schedule 40 PVC pipe connected to 0.5 m - 1.5 m lengths of No. 10 slotted PVC screen. The pipe meets ASTM D1784 Standards for PVC filler (only 200 mesh marble dust) and is high impact strength and uniform diameter. The pipe also meets ASTM F480 specifications for

thermal plastic well casing. Pipe and screen are laboratory washed and individually wrapped in plastic prior to shipment to the landfill.

The screened interval in each installation was sand packed with Grade 3 washed silica sand. Bentonite seals were placed above the sand packed section to prevent vertical movement of water within the drill hole. The remaining space in each borehole was backfilled with drill cuttings. A 150 mm square steel protective casing with lockable cap was placed over the pipe stick-up at each installation.

B.3 Formation Sampling and Analysis

Splitspoon samples were taken for detailed inspection and logging of stratigraphic units. A total of 30 splitspoon samples were taken from seven boreholes (see borehole logs, Appendix C). The splitspoon samples were visually inspected, logged in detail and discarded. A total of six samples were submitted for grain size analysis, as representative of a various stratigraphic units encountered. The grain size distribution curves are included as Appendix D.

B.4 Water Level Measurements

Depth from top of PVC pipe to the static water was measured in all of the monitors except B1 on five separate occassions (22, 28 July, 15, 31 August and 30 September). To convert depth-to-water to geodetic elevations, the top of each installation was surveyed with respect to the leachate manhole located on the west side of the landfill. This manhole is reported to have an elevation of 300.838 metres above sea level.

B.5 In-situ Hydraulic Testing

On 31 August 1988, rising head hydraulic conductivity tests were conducted on the eight overburden ground water monitors. Each monitor was bailed as free of water as possible and the rate of recovery of the water level in the monitor was recorded. Hvorslev's basic time lag method (Hvorslev, 1951) was then used to calculate the approximate bulk hydraulic conductivities over the screened interval of each monitor.

On 1 September 1988, a 1.5 hr pump test was conducted on the bedrock monitor B1. A ¼ hp, generator driven submersible pump was temporarily installed in the well. The well was pumped at a constant rate of 30 l/min (6.6 igpm) and drawdown was measured. After cessation of pumping, recovery in the well was monitored for 1.5 hours.

Jacob's residual drawdown method (Kruseman and DeRidder, 1970) was used to interpret the drawdown and recovery data.

B.6 Water and Leachate Sampling

One suite of surface water, ground water and leachate samples was collected. The locations of the sampling stations are indicated on Figure 3. Water and leachate samples were submitted to two independent laboratories for analysis. The results of all analyses are included in Appendix F. All organic analyses were performed by Mann Testing Laboratories Ltd. of Mississauga, Ontario. The remaining parameters were analyzed by Barringer Magenta Ltd.

B.6.1 Sampling Protocol

The following section details the protocol used in collecting water samples at each of the monitoring stations during the sampling program. Rigid adherence to the procedures outlined was required to ensure that representative samples were taken and that accurate laboratory determinations could be made. The sampling protocol was taken from the MOE report titled "A Guide to the Collection and Submission of Samples for Laboratory Analysis", July 1985. Field pH and conductivity measurements were taken in accordance with ASTM standard methods.

1. The depths-to-water surface in all monitoring wells were measured with an electric tape, from the top of the standpipe.

2. To ensure that ground water samples were representative of formation water, and not stagnant water from the well bore, a minimum of three bore volumes were purged prior to sampling. Purging and sampling was performed using a PVC bailer.

   Between monitors, the bailer was thoroughly rinsed with distilled water, to prevent cross-contamination.

3. Ground water samples were collected using a PVC bailer. Surface water samples were collected by directly submerging the sample bottles below the water surface.

4. All samples were collected in new or laboratory washed and prepared bottles. Each bottle and cap were rinsed three times with sample water, prior to collecting the sample. Surgical gloves were worn at all times as protection and to prevent external contamination of the sample.

5. All samples were clearly labelled, stored on ice, and shipped to the laboratory within 48 hours of sampling. Strict adherence to protocol was maintained throughout the program.

6. To ensure quality control at the laboratory, one duplicate sample and one field blank were submitted for analysis.

B.7 Methane Gas Monitoring

A portable "TLV Sniffer" was used to determine total combustible gas concentrations in each monitor installation and also in hand augered holes (maximum depth of 1.3 m). A total of 47 measurements were taken between 20 July 1988 and 28 July 1988. The sample locations are shown on Figure 5. The instrument is factory calibrated for hexane gas and by use of a multiplying factor (1.58) the ppm readings are easily converted to methane gas concentration.

Permanent gas monitors consisting of slotted 2.5 cm diameter PVC pipe were installed at each borehole.

B.8 Vegetation Assessment

An experienced biologist visited the landfill site to determine the effects of the landfill on local vegetation.

APPENDIX C
BOREHOLE LOGS

DILLON

BOREHOLE NO. N - 1

PROJECT NAME NEWTON LANDFILL

CLIENT MOE

PROJECT NO. 2273-02

GEOLOGIST / ENGINEER SED

DATE July 19 88

DESCRIPTION	Stratg.	DEPTH m	DEPTH ft.	SAMPLES no.	SAMPLES type	SAMPLES "N"	INSTAL. DETAIL	REMARKS
Ground Elevation (m.a.s.l) 299.76							II I	Steel Protective Casing 50 mm PVC Sch 40 Pipe Stick ups I .452 II .46
Silty fine to Coarse Sand		1			ss			Bentonite
			5		ss			
		2						25 mm PVC slotted gas monitor
		3	10		ss			
		4						Aug 15 88 Silica Sand
		5	15		ss			Bentonite
6.10		6	20		ss			Native Backfill
Silty fine to coarse sand with gravel 7.92		7						
		8	25		ss			Bentonite
Silty Sand 8.83								Silica Sand
Dense silty sand 9.44		9	30		ss			1.5 m, 50 mm Ø PVC #10 slot screen
		10						
			35					

DILLON

BOREHOLE NO. N-2

PROJECT NAME NEWTON LANDFILL

CLIENT MOE

PROJECT NO. 2273-02

GEOLOGIST / ENGINEER SED

DATE July 20 88

DESCRIPTION	Strata.	DEPTH m	DEPTH ft.	SAMPLES no.	SAMPLES type	SAMPLES "N"	INSTAL. DETAIL	REMARKS
Ground Elevation 304.24								Steel Protective Casing 50 mm Ø Sch 40 PVC Pipe
Topsoil 0.61								Bentonite
Fine to Coarse Sand with Little Silt		1						
			5	ss				
		2						25 mm Ø PVC gas monitor
		3	10	ss				
		4						
			15	ss				
		5						
		6	20	ss				Native Backfill
		7						Aug 15 '88
			25	ss				Silica Sand
		8						
9.10		9	30					1.5 m of 50 mm Ø Screen #10 Slot
			35					

DILLON

BOREHOLE NO. N-3

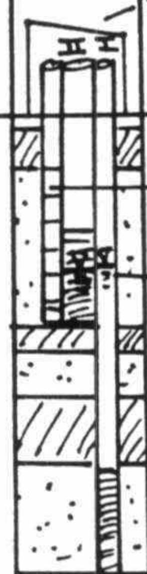
PROJECT NAME NEWTON LANDFILL

CLIENT MOE

PROJECT NO. 2273-02

GEOLOGIST / ENGINEER SED

DATE July 20 88

DESCRIPTION	Strata.	DEPTH m	DEPTH ft.	SAMPLES no.	SAMPLES type	SAMPLES "N"	INSTAL. DETAIL	REMARKS
Ground Elevation (m.a.s.l) 292.26								Steel Protective Casing Stick up I 0.851 II 0.851
Topsoil Rubble 0.6								Bentonite
Black Fill 1.0		1						25 mm ø PVC
Medium Sand 2.13		2	5		ss ss			Silica Sand Aug 15 88
GREY Silty fine Sand 4.9		3 4 5	10 15		ss ss			Bentonite Native Fill odourous
Sand and Gravel 6.10		6	20		ss			Silica Sand

Piezometer materials:

50 mm ø PVC Sch 40 Pipe

1.5 m screen

10 slot

DILLON

BOREHOLE NO. N-4

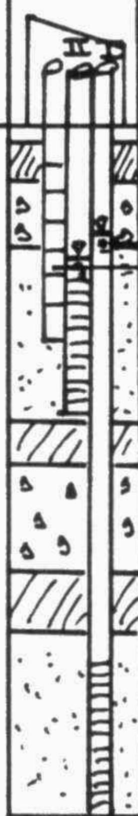
PROJECT NAME NEWTON LANDFILL

CLIENT MOE

PROJECT NO. 2273-02

GEOLOGIST / ENGINEER SED

DATE July 22 88

DESCRIPTION	Strata.	DEPTH m	DEPTH ft.	SAMPLES no.	SAMPLES type	SAMPLES "N"	INSTAL. DETAIL	REMARKS
Ground Elevation (m.a.s.l) 290.04								Steel Cover Stick-up I 0.19 II 0.145
Dark Gravel and Sand 1.0		1						Bentonite
		2	5		ss			Native Backfill — Aug 15 88 25 mm Ø PVC
		3	10		ss			Silica Sand
FINE GREY SAND 4.57		4						
		5	15		ss			Bentonite Native Backfill
Dense Silty fine to Coarse Sand with gravel		6	20		ss			Bentonite
		7						
		8	25		ss			Silica Sand #3
9.04		9	30		ss			Piezometer Materials: 50 mm Ø Sch. 40 PVC pipe
		10	35					

DILLON

BOREHOLE NO. B - 1

PROJECT NAME NEWTON LANDFILL

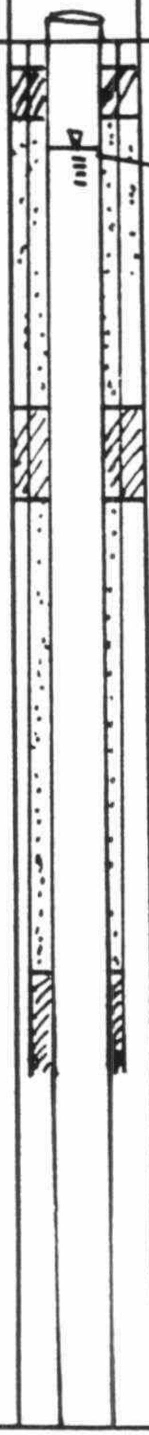
CLIENT MOE

PROJECT NO. 2273-02

GEOLOGIST / ENGINEER SED

DATE July 22

DESCRIPTION	Strata.	DEPTH m	DEPTH ft.	SAMPLES no.	SAMPLES type	SAMPLES "N"	INSTAL. DETAIL	REMARKS
Ground Elevation (m.a.s.l.) 290.06								100 mm Steel Casing with locking cap Stick-up = 0.15 m
Dark sand and Gravel 1.0		1	5					Bentonite Surface Seal
Silty fine to coarse sand and gravel 4.57		2, 3, 4	10, 15					Aug 15 88 Native Backfill
Dense silty fine to coarse sand with gravel 9.44		5, 6, 7, 8, 9	20, 25, 30					Bentonite Seal
Coarse sand and boulders 12.49		10, 11, 12	35, 40					
Limestone		13, 14, 15, 16, 17, 18	45, 50, 55, 60					Bentonite Seal
Bottom of Hole 18.28								



DILLON

BOREHOLE NO. L-1

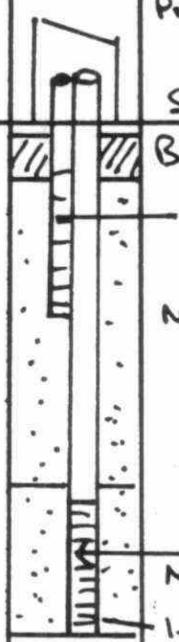
PROJECT NAME NEWTON LANDFILL

CLIENT MOE

PROJECT NO. 2273-02

GEOLOGIST / ENGINEER SED

DATE July 20

DESCRIPTION	Stratg.	DEPTH m	DEPTH ft.	SAMPLES no.	SAMPLES type	SAMPLES "N"	INSTAL. DETAIL	REMARKS
Ground Elevation (m.a.s.l.) 300.84								Protective Casing Stick-up = 0.66
SAND COVER 0.60								Bentonite
REFUSE 5.49		1 2 3 4 5	5 10 15					Native Backfill
SILTY (Black) SAND 7.01		6 7	20 25		SS			Aug 15'88 Native Sand 1.5 m #10 slot Screen

Piezometer Material

50 mm Φ Sch 40 PVC Pipe

Gas Monitor

25 mm Φ Sch 40 PVC Pipe

APPENDIX D
GRAIN SIZE DISTRIBUTION CURVES

DILLON

BOREHOLE NO. L-2

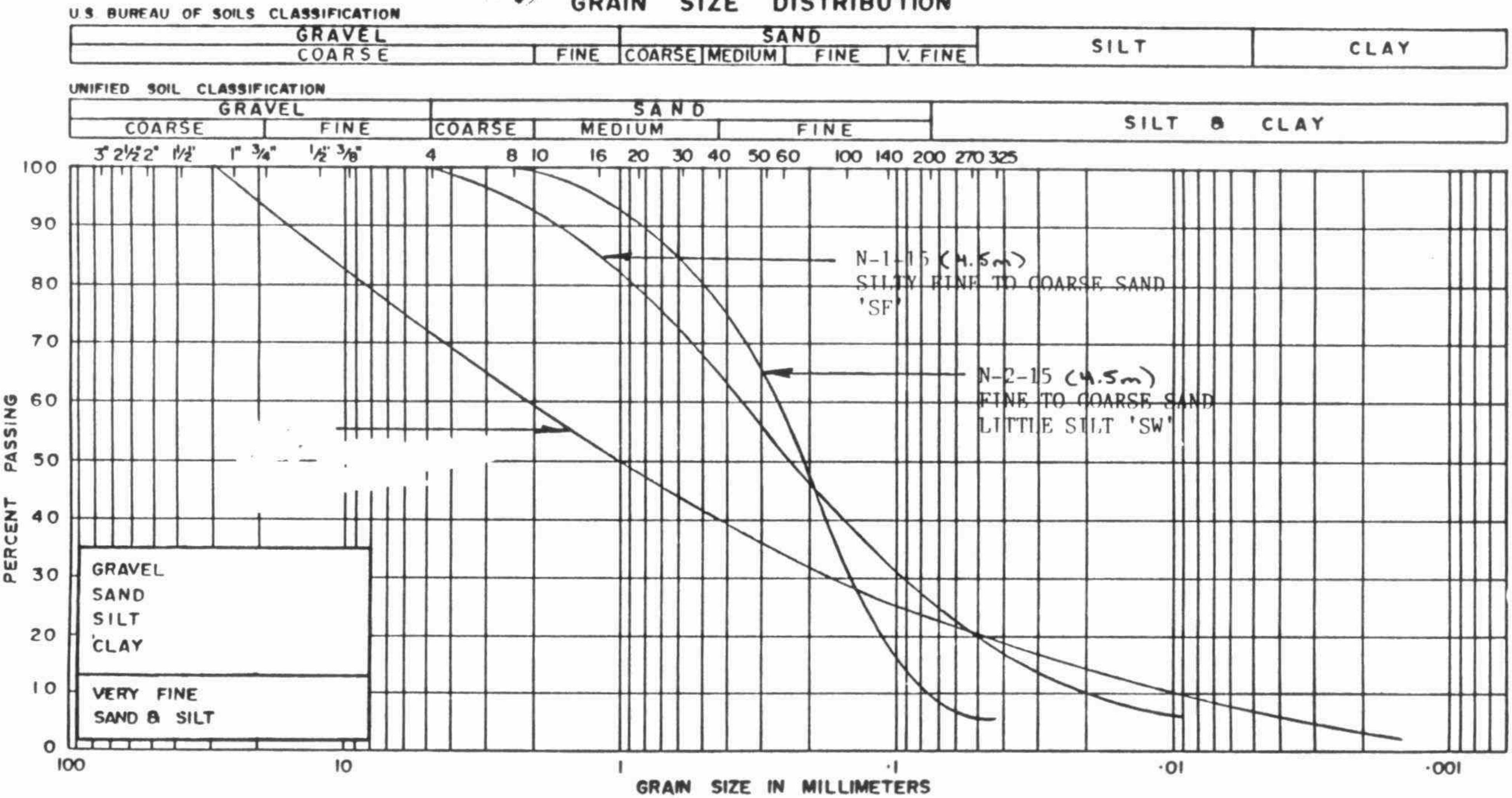
PROJECT NAME NEWTON LANDFILL
CLIENT MOE
PROJECT NO. 2273-02
GEOLOGIST / ENGINEER SED
DATE July 20 88

DESCRIPTION	Stratg.	DEPTH m	DEPTH ft.	SAMPLES no.	SAMPLES type	SAMPLES "N"	INSTAL. DETAIL	REMARKS
Ground Elevation (m.a.s.l) 302.29								Steel Protective Casing Stick up = 0.99
NO COVER								Bentonite
		1	5					25 mm Ø PVC
		2						
Refuse		3	10		grab			Native Backfill
		4	15					50 mm Sch 40 PVC Pipe
		5						
		6	20					
		7	25					Bentonite Aug 15 '88 (7.95m)
8.22		8						Silica Sand
Silty Sand 9.10		9	30		ss			1.5 m #10 Screen

Soil-Eng Limited

REFERENCE Nº 8807-M.92

GRAIN SIZE DISTRIBUTION



PROJECT:

LOCATION:

BOREHOLE Nº:

SAMPLE Nº:

DEPTH:

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and 'Group Symbol:'

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

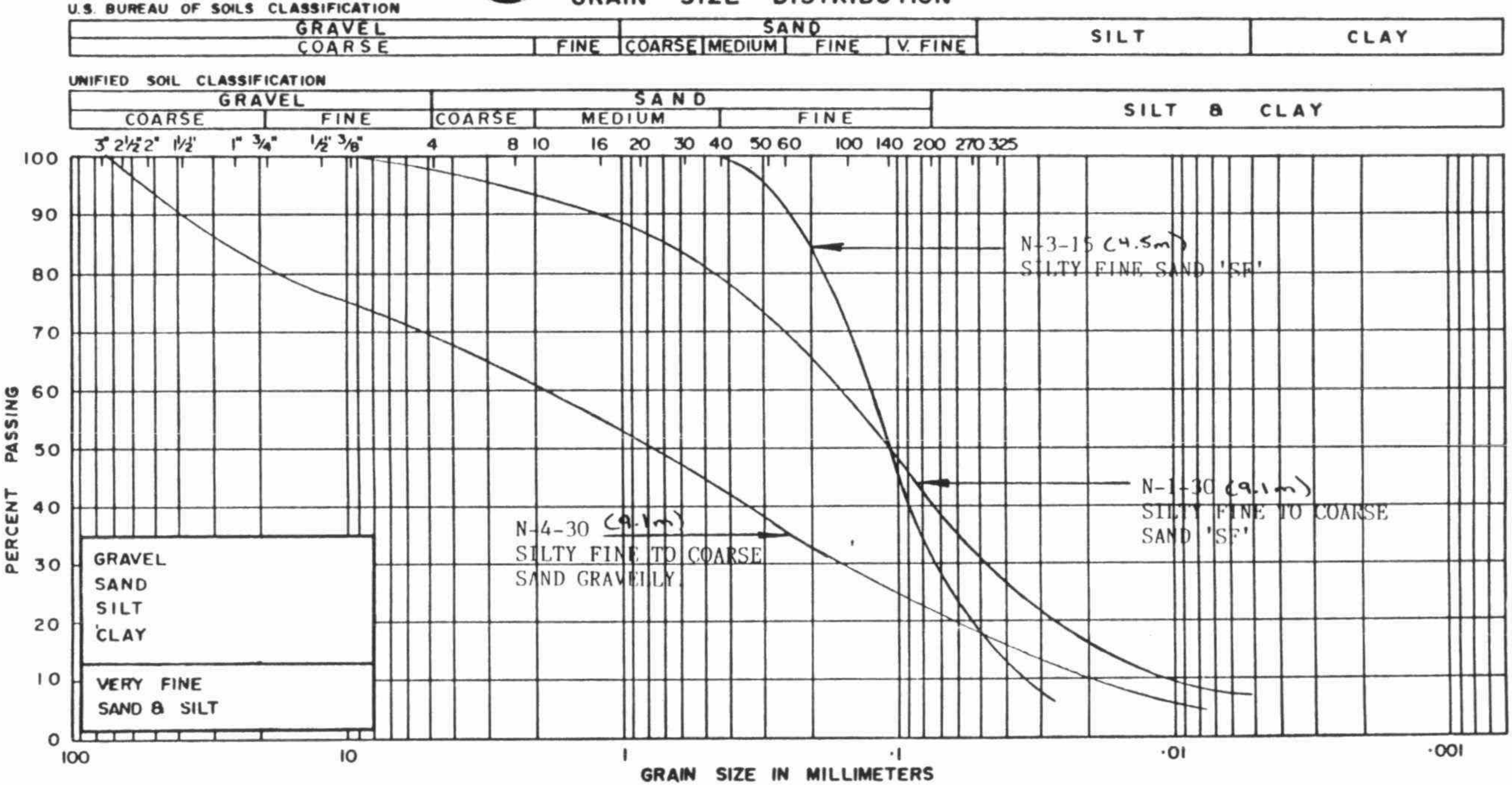
PERMEABILITY (cm./sec.) =

FIGURE: 1

Soil-Eng Limited

REFERENCE Nº 8807-M.92

GRAIN SIZE DISTRIBUTION



PROJECT:

LOCATION:

BOREHOLE Nº:

SAMPLE Nº:

DEPTH:

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and 'Group Symbol'

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

PERMEABILITY (cm./sec.) =

FIGURE: 4

Soil-Eng Limited

REFERENCE Nº 8807-M.92

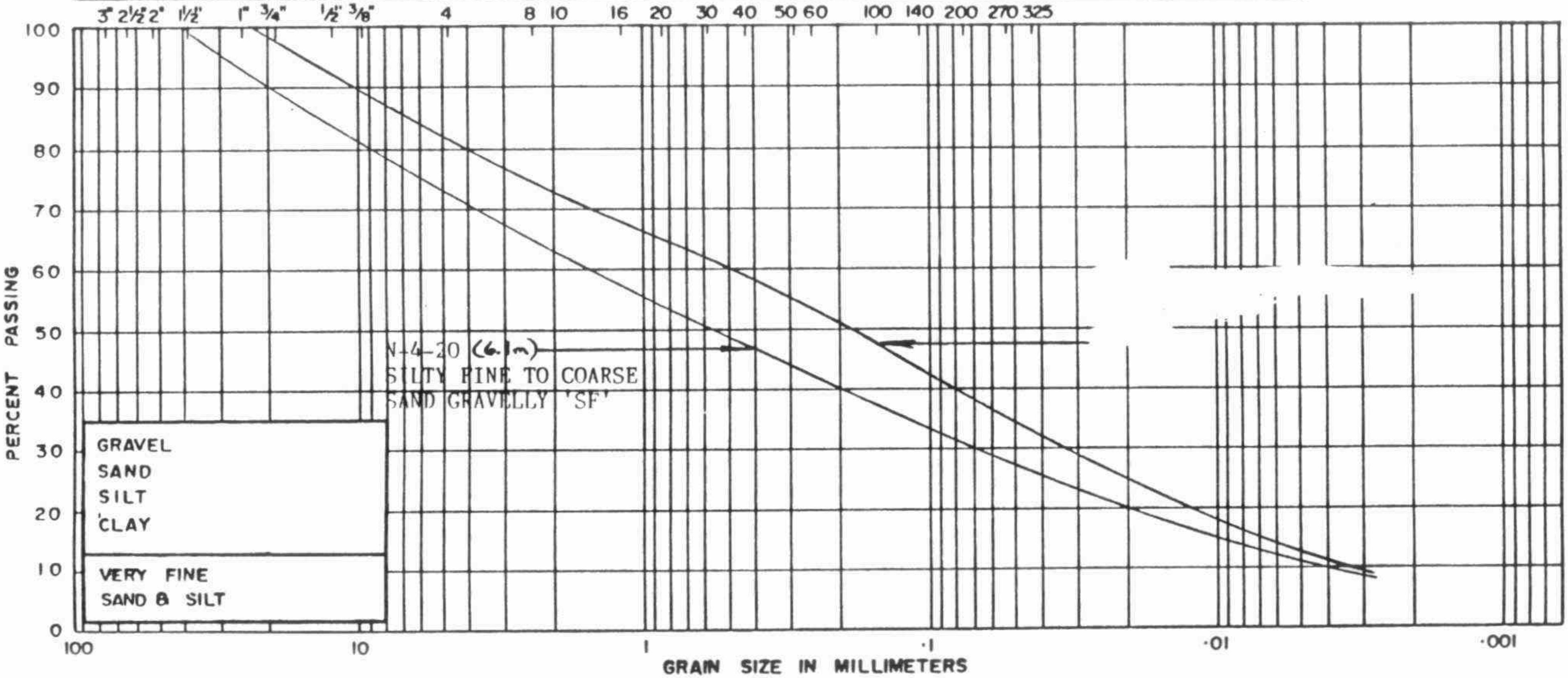
GRAIN SIZE DISTRIBUTION

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



PROJECT:

LOCATION:

BOREHOLE Nº:

SAMPLE Nº:

DEPTH:

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and 'Group Symbol:'

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

PERMEABILITY (cm./sec.) =

FIGURE: 3

APPENDIX E
RISING HEAD TEST DATA

DILLON
Consulting Engineers · Planners · Environmental Scientists

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED
File No: 2273-02
Date: Aug 31 88
Borehole No: N-1 I
Conducted By: SED
Page: 1
Static Water Level: 3.39
Measuring Point: T.O.P.
Drawdown at t= 0 (Ho): 4.46 (1.07)

Date	Time (hrs. & mins.)	Elapsed Time (min)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		0	3.39	0		
		.5	4.30	0.91	.85	
		.75	4.16	.77	.72	
		1	4.03	.64	.60	
		1.25	3.95	.56	.52	
		1.50	3.88	.49	.48	
		2	3.76	.37	.35	
		2.5	3.68	.29	.27	
		3	3.61	.22	.21	
		4	3.54	.15	.14	
		5	3.49	.10	.09	
		6	3.46	.07	.07	

DILLON

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED
File No: 2273-02
Date: Aug 31 88

Borehole No: N I - II
Conducted By: SED
Page: 1

Static Water Level: 3.24
Measuring Point: T. O. P.

Drawdown at t= 0 (Ho): 4.06 (.82)

Date	Time (hrs. & mins.)	Elapsed Time (MIN)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		0	3.24	0		
		.333	4.04	.80	.98	
		.66	4.00	.76	.93	
		1	3.97	.73	.89	
		1.25				
		1.50	3.94	.70	.85	
		2	3.90	.66	.80	
		3	3.83	.59	.72	
		4	3.78	.54	.66	
		5	3.72	.48	.59	
		6	3.67	.43	.52	
		7				
		8				
		9	3.56	.32	.39	
		10	3.53	.29	.35	
		15	3.40	.16	.20	
		18	3.36	.12	.15	
		20	3.33	.09	.11	

DILLON

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED (NEWTON) File No: 2273-02 Date: Aug 31 88

Borehole No: N-2 Conducted By: SED Page: 1

Static Water Level: 7.58 Measuring Point:

Drawdown at t= 0 (Ho): (8.16) .58

Date	Time (hrs. & mins.)	Elapsed Time (sec)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		0	7.58	0	0	
		30	7.60	.02	.03	
		45	7.59	.01	.017	
		60	7.58	0	0	

DILLON

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED (NEWTON) File No: 22~~7~~3-02 Date: Aug 31 88

Borehole No: N-3 - I Conducted By: SED Page: 1

Static Water Level: 2.00 Measuring Point: T.O.P.

Drawdown at t= 0 (Ho): 2.58 (.58)

Date	Time (hrs. & mins.)	Elapsed Time ( )	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		0	2.00	0	.~~88~~	
		.25	2.51	.51	.88	
		.50	2.45	.45	.78	
		.75	2.40	.40	.69	
		1.0	2.35	.35	.60	
		1.50	2.27	.27	.47	
		2.0	2.21	.21	.36	
		2.5	2.17	.17	.29	
		3.0	2.13	.13	.22	
		4.0	2.08	.08	.14	
		5.0	2.05	.05	.09	
		6.0	2.03	.03	.05	

DILLON

Consulting Engineers . Planners
Environmental Scientists

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED
File No: 2273-02
Date: Aug 31 88

Borehole No: N-3-II
Conducted By: SED
Page: 1

Static Water Level: 2.02
Measuring Point: T.O.P.

Drawdown at t= 0 (Ho): 2.60 (.58)

Date	Time (hrs. & mins.)	Elapsed Time (min)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		0	2.02	0		
		.33	2.41	.39	.67	
		.50	2.36	.34	.58	
		.83	2.28	.26	.45	
		1	2.25	.23	.40	
		1.25	2.22	.20	.34	
		1.50	2.18	.16	.28	
		1.75	2.17	.15	.26	
		2.0	2.15	.13	.22	
		2.5	2.12	.10	.17	
		3	2.11	.09	.16	
		4	2.09	.07	.12	
		5	2.08	.06	.10	
		7	2.07	.05	.09	
		10	2.07	.05	.09	

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Consulting Engineers · Planners · Environmental Scientists

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED
File No: 2273-02
Date: Aug 31 88
Borehole No: N4 - I
Conducted By: SED
Page: 1
Static Water Level: 1.58
Measuring Point: T.O.P.
Drawdown at t= 0 (Ho): .58

Date	Time (hrs. & mins.)	Elapsed Time (MIN)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
	0	0	1.58	0		
		.25	2.10	.52	.90	
		.50	2.05	.47	.81	
		.75	1.99	.41	.71	
		1	1.95	.37	.64	
		1.25	1.91	.33	.57	
		1.50	1.87	.29	.50	
		2	1.80	.22	.38	
		2.5	1.77	.19	.33	
		3	1.73	.15	.26	
		4	1.67	.09	.15	
		5	1.63	.05	.09	
		6	1.61	.03	.05	
		7	1.60	.02	.03	

DILLON

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED

File No: 2273-02

Date: Aug 31

Borehole No: N4-II

Conducted By: SED

Page: 1

Static Water Level: 1.82

Measuring Point: T.O.P.

Drawdown at t= 0 (Ho): 1.74

Date	Time (hrs. & mins.)	Elapsed Time (MIN)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		0	1.82	0		
		.25	3.51	1.69	.97	
		.50	3.50	1.68	.965	
		1	3.495	1.675	.962	
		2	3.495	1.675	.962	
		5	3.49	1.67	.960	
		8	3.48	1.66	.954	
		11	3.475	1.655	.951	
		13	3.47	1.65	.948	
		143	3.21	1.39	.80	

WATER LEVEL MEASUREMENTS (FIELD)

DILLON

TEST CONDUCTED BY: SED MEASURED BY: SED

LOCATION OF PROJECT: Cambridge WELL LOCATION: B-1

STATUS Pumping (pumping or observation well) R = (distance from pumping well) DATE PAGE

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water Level	Depth to water	Draw-down	Q = discharge		REMARKS (ie. pump adjustments, water temp. static levels, etc.)
	0	0			1.58	0			
		2							
		6					30L/min		
		8			2.33	.75			
		10			2.38	.80			
		12			2.40	.82			
		15			2.43	.85			
		22			2.50	.92			
		26			2.52	.94			
		40			2.58	1.00			
		45			2.60	1.02			
		60			2.64	1.06			
		80			2.66	1.08			
		87			2.68	1.10	30L/min		

WATER LEVEL MEASUREMENTS (FIELD) DILLON

TEST CONDUCTED BY: SED MEASURED BY: SED

LOCATION OF PROJECT: NEWTON WELL LOCATION: N4-I

STATUS Observation (pumping or observation well) R= 10 m (distance from pumping well) DATE Sept 1 PAGE 1

Date	Time hrs. & mins.	Elapsed time in mins.	Tape Reading at Meas. Point	Tape Reading at Water Level	Depth to water	Draw-down	Q = discharge		REMARKS (ie. pump adjustments, water temp. static levels, etc.)
		0			1.58	0			
		2			1.82	.24			
		6			2.10	.52			
		8							
		10			2.19	.61			
		12			2.24	.66			
		15			2.27	.69			
		22			2.35	.77			
		26			2.37	.79			
		40			2.43	.85			
		45			2.46	.88			
		60			2.50	.92			
		80			2.52	.94			
		87			2.53	.95			

DILLON
Consulting Engineers · Planners
Environmental Scientists

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED (NEWTON)   File No: 2273-02   Date: Aug 31 88
Borehole No: L-1   Conducted By: SED   Page: 1
Static Water Level: 5.70   Measuring Point: T.O.P.
Drawdown at t= 0 (Ho): 6.28 .38

Date	Time (hrs. & mins.)	Elapsed Time (MIN)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		.33	6.20	.50	.86	
		.50	6.15	.45	.78	
		.83	6.09	.39	.67	
		1	6.05	.35	.60	
		1.25	6.00	.30	.52	
		1.50	5.99	.29	.50	
		1.75	5.95	.25	.43	
		2	5.92	.22	.38	
		2.5	5.88	.18	.31	
		3.0	5.84	.14	.24	
		3.5	5.82	.12	.21	
		4	5.79	.09	.15	
		5	5.76	.06	.10	
		6	5.74	.04	.07	

DILLON

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED LANDFILLS File No: 2281-02 Date: Aug 31 88

Borehole No: L-1 (NEWTON) Conducted By: SED Page: 1

Static Water Level: 5.70 Measuring Point:

Drawdown at t= 0 (Ho): 6.28 (.58)

Date	Time (hrs. & mins.)	Elapsed Time ( )	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
		0	5.70	0	D	
		.33	6.20	.50	.86	
		.50	6.15	.45	.78	
		.83	6.09	.39	.67	
		1	6.05	.35	.60	
		1.25	6.00	.30	.52	
		1.3	6.99	.29	.50	
		1.75	5.95	.25	.43	
		2	5.92	.22	.38	
		2.5	5.88	.18	.31	
		3.00	5.84	.14	.24	
		3.30	5.82	.12	.21	
		4.00	5.79	.09	.16	
		5.00	5.76	.06	.10	
		6.00	5.74	.04	.07	

DILLON

IN-SITU HYDRAULIC CONDUCTIVITY TEST

Project Name: MOE CLOSED (NEWTON) File No: 2273-02 Date: Aug 31

Borehole No: L-2 Conducted By: SED Page: 1

Static Water Level: 8.03 Measuring Point: T.O.P.

Drawdown at t= 0 (Ho): 7.03 (1 m) Injection 2 l Distilled

Date	Time (hrs. & mins.)	Elapsed Time (SEC)	Depth To Water (m)	Drawdown, H (m)	H/Ho	Remarks
	.167	10	7.78	.25	.25	
	.334	20	7.83	.20	.20	
	.50	30	7.86	.17	.17	
	.67	40	7.89	.14	.14	
	.83	50	7.89	.14	.14	
	1	60	7.90	.13	.13	
	1.17	70	7.905	.125	.125	
	1.5	90	7.92	.11	.11	
	2	120	7.93	.10	.10	
	2.5	150	7.95	0.08	.08	
	3	180	7.96	0.07	.07	
	4	240	7.97	0.06	.06	
	5	300	7.98	0.05	.05	

APPENDIX F
WATER QUALITY DATA

[redacted]RLING[redacted]VE
[redacted]LE, ON
M9W 5G2
(416) 675-3870

BARRINGER MAGENTA

F[redacted]495
DATE: 16/10/88
MATRIX: AQ

M.M.DILLON (KIRA ONYSKO) PROJ:2273-02 WO NO: 88-4495 PAGE: 1

SAMPLE ID	AG MG/L	AL MG/L	B MG/L	BA MG/L	BE MG/L	CA MG/L	CD MG/L	CO MG/L	CR MG/L	CU MG/L	FE MG/L	K MG/L
2273-2001 N3I	.007	<.01	.210	.195	<.0005	81.1	.01	<.05	.02	<.008	2.89	14.4
2273-2002 N1I	<.005	.03	.022	.067	<.0005	71.6	<.01	<.05	.02	<.008	.10	2.1
2273-2003 N1II	<.005	.15	.036	.081	<.0005	80.2	<.01	<.05	.02	<.008	.30	2.6
2273-2004 N2	<.005	<.01	.015	.023	<.0005	117	<.01	<.05	.02	<.008	.18	1.0
2273-2005 N3I	<.005	<.01	.202	.190	<.0005	77.3	<.01	<.05	.02	<.008	2.44	14.0
2273-2006 N3II	<.005	<.01	.555	.348	<.0005	119	.01	<.05	.03	<.008	8.32	32.3
2273-2007 N4I	.010	<.01	.027	.128	<.0005	96.5	<.01	<.05	.02	<.008	.67	2.4
2273-2008 N4II	.020	<.01	.114	.153	<.0005	60.5	<.01	<.05	.02	<.008	.13	7.7
2273-2011 B1	.013	<.01	.019	.149	<.0005	89.0	<.01	<.05	.02	<.008	1.18	7.0
2273-2017 Blank	.012	.01	<.004	<.005	<.0005	.08	<.01	<.05	<.01	.008	<.01	<.5
CONTROL DATA	--	--	--	--	--	--	--	--	--	--	--	--
BLANK	<.005	<.01	<.004	<.005	<.0005	<.01	<.01	<.05	<.01	<.008	<.01	<.5
2273-2017	.012	.01	<.004	<.005	<.0005	.08	<.01	<.05	<.01	.008	<.01	<.5
2273-2017-R	.007	.02	<.004	<.005	<.0005	.09	<.01	<.05	<.01	.008	<.01	.6
2273-2002	--	--	--	--	--	--	--	--	--	--	--	--
2273-2002-R	--	--	--	--	--	--	--	--	--	--	--	--
CONTROL STD	<.005	1.01	.198	1.03	.0193	<.01	.21	.23	.20	.205	.99	<.5
CONTROL.EST.	--	1.00	.200	--	.0200	--	.20	.20	.20	.200	1.00	--
EPA STD	<.005	<.01	.107	<.005	<.0005	39.1	.01	<.05	<.01	<.008	.05	9.7
EPA.STD(CRT)	--	--	--	--	--	40.0	--	--	--	--	--	10.0

BARRINGER MAGENTA
M9W 5G2
(416) 675-3870

FILE: 18_4495
DATE: 16/10/88
MATRIX: AQ

M.M.DILLON (KIRA ONYSKO) PROJ:2273-02 WO NO: 88-4495

SAMPLE ID		MG MG/L	MN MG/L	MO MG/L	NA MG/L	NI MG/L	P MG/L	PB MG/L	SI MG/L	SR MG/L	TH MG/L	TI MG/L	V MG/L
2273-2001	N3I	37.1	.11	.3	45.4	.07	<.5	<.05	9.83	.215	<.05	<.005	<.005
2273-2002	N1I	27.4	.18	<.2	8.1	<.05	<.5	<.05	6.15	.117	<.05	<.005	.006
2273-2003	N1II	27.6	.51	<.2	34.1	.06	<.5	<.05	5.69	.186	<.05	<.005	<.005
2273-2004	N2	27.5	.06	.2	4.8	<.05	<.5	<.05	5.90	.167	<.05	<.005	<.005
2273-2005	N3I	35.9	.10	.3	45.4	<.05	<.5	<.05	9.52	.214	<.05	<.005	<.005
2273-2006	N3II	42.4	1.21	.4	94.5	<.05	<.5	<.05	11.0	.365	<.05	<.005	<.005
2273-2007	N4I	33.3	.11	<.2	17.9	<.05	<.5	<.05	7.84	.270	<.05	<.005	.006
2273-2008	N4II	41.6	.02	.5	96.0	<.05	<.5	<.05	9.44	.319	<.05	<.005	.006
2273-2011	B1	26.2	.06	<.2	31.0	<.05	<.5	<.05	8.26	.146	<.05	<.005	.010
2273-2017	Blank	<.01	<.01	<.2	<.5	<.05	<.5	<.05	<.05	<.001	<.05	<.005	.008
CONTROL DATA		--	--	--	--	--	--	--	--	--	--	--	--
BLANK		.02	<.01	<.2	<.5	<.05	<.5	<.05	<.05	<.001	<.05	<.005	<.005
2273-2017		<.01	<.01	<.2	<.5	<.05	<.5	<.05	<.05	<.001	<.05	<.005	.008
2273-2017-R		<.01	<.01	<.2	<.5	<.05	<.5	<.05	<.05	<.001	<.05	<.005	.006
2273-2002		--	--	--	--	--	--	--	--	--	--	--	--
2273-2002-R		--	--	--	--	--	--	--	--	--	--	--	--
CONTROL STD		<.01	.20	<.2	<.5	.20	<.5	.21	<.05	.197	<.05	.198	.206
CONTROL.EST.		--	.20	--	--	.20	--	.20	--	.200	--	.200	.200
EPA STD		10.0	<.01	<.2	40.9	<.05	<.5	--	.44	.021	<.05	<.005	.006
EPA.STD(CRT)		10.0	--	--	40.0	--	--	--	--	--	--	--	--

BARRINGER MAGENTA
LINGW E
REXDALE, ONTARIO
M9W 5G2
(416) 675-3870

F : 195
DATE: 16/10/88
MATRIX: AQ

SAMPLE ID		ZN MG/L	ZR MG/L	ALK PPMCACO3	AS UG/L	BOD MG/L	DOC MG/L	HG UG/L	NH3-N MG/L	PH	PHENOLS UG/L
2273-2001	N3I	.04	<.05	419	<1	--	7.0	<.05	--	7.69	1.0
2273-2002	N1I	.04	<.05	234	<1	12.5	2.3	<.05	.04	7.72	<.5
2273-2003	N1II	.05	<.05	281	<1	6.0	1.8	<.05	.03	7.49	<.5
2273-2004	N2	.05	<.05	373	<1	11.0	1.4	<.05	<.02	7.75	<.5
2273-2005	N3I	.04	<.05	421	<1	24.0	7.2	<.05	2.20	7.82	<.5
2273-2006	N3II	.05	<.05	704	<1	27.5	19.8	<.05	2.21	7.81	1.5
2273-2007	N4I	.04	<.05	263	<1	5.0	2.1	<.05	.23	7.63	5.0
2273-2008	N4II	.04	<.05	289	<1	18.0	9.3	<.05	.17	7.72	<.5
2273-2011	B1	.05	<.05	247	<1	3.5	1.9	<.05	.16	8.02	1.0
2273-2017	Blank	<.01	<.05	1.0	<1	--	.5	<.05	--	6.09	1.0
CONTROL DATA		--	--	--	--	--	--	--	--	--	--
BLANK		<.01	<.05	2.3	<1	<.5	<.2	<.05	<.02	--	<.5
2273-2017		<.01	<.05	1.0	<1	--	.5	<.05	--	6.09	1.0
2273-2017-R		.01	<.05	1.0	<1	--	.5	<.05	--	6.13	1.0
2273-2002		--	--	--	--	12.5	--	--	.04	--	--
2273-2002-R		--	--	--	--	11.5	--	--	.04	--	--
CONTROL STD		.19	.20	252	--	3.9	9.5	3.44	.55	4.43	9.5
CONTROL.EST.		.20	.20	250	--	4.0	10.0	3.20	.50	4.45	10.0
EPA STD		.02	<.05	--	43	--	--	--	--	--	--
EPA.STD(CRT)		--	--	--	45	--	--	--	--	--	--

BARRINGER MAGENTA
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DATE: 16/10/88
MATRIX: AQ

M.M.DILLON (KIRA ONYSKO) PROJ:2273-02 WO NO: 88-4495

SAMPLE ID		F- MG/L	CL- MG/L	NO2-N MG/L	BR- MG/L	NO3-N MG/L	PO4-3 MG/L	SO4- MG/L
2273-2001	N3I	<.10	59.4	<.01	<.05	<.01	<.1	17.0
2273-2002	N1I	.12	5.85	.05	<.05	.46	<.1	32.8
2273-2003	N1II	.18	12.7	.05	<.05	.23	<.1	55.3
2273-2004	N2	<.10	24.4	.04	<.05	1.88	<.1	23.1
2273-2005	N3I	.30	65.2	<.10	<.05	<.01	<.1	14.8
2273-2006	N3II	<.10	176	<.10	.60	<.01	<.1	1.85
2273-2007	N4I	.40	60.8	<.10	<.05	<.01	<.1	56.5
2273-2008	N4II	<.10	200	<.10	1.07	<.01	<.1	7.82
2273-2011	B1	<.10	73.3	<.10	<.05	<.01	<.1	27.3
2273-2017	Blank	<.01	.12	<.01	<.05	<.01	<.1	<.05
CONTROL DATA		--	--	--	--	--	--	--
BLANK		<.01	<.01	<.01	<.05	<.01	<.1	<.05
2273-2017		<.01	.12	<.01	<.05	<.01	<.1	<.05
2273-2017-R		<.01	.15	<.01	<.05	<.01	<.1	<.05
2273-2002		--	--	--	--	--	--	--
2273-2002-R		--	--	--	--	--	--	--
CONTROL STD		.99	10.2	1.15	1.05	1.98	2.0	20.2
CONTROL.EST.		1.00	10.0	1.00	1.00	2.00	2.0	20.0
EPA STD		--	--	--	--	--	--	--
EPA.STD(CRT)		--	--	--	--	--	--	--

BARRINGER MAGENTA
[illegible] RLINGTON [illegible] VE
[illegible] LE, ON [illegible]
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FILE: T[illegible]04
DATE: 13/10/88
MATRIX: AQ

Q.R.

M.M.DILLON (KIRA ONYSKO) PROJ:2273-01 WO NO: 88-4504 PAGE: 1

SAMPLE ID	AG MG/L	AL MG/L	B MG/L	BA MG/L	BE MG/L	CA MG/L	CD MG/L	CO MG/L	CR MG/L	CU MG/L	FE MG/L	K MG/L
2273-2009 L1	<.005	<.01	.532	.030	<.0005	205	<.01	<.05	<.01	<.008	.32	27.3
2273-2010 L2	<.005	.05	7.17	.324	<.0005	276	<.01	<.05	.01	<.008	91.5	53.0
2273-2012 SW1	<.005	<.01	.106	.133	<.0005	130	<.01	<.05	.01	.016	2.45	12.2
2273-2013 SW2	<.005	.23	.025	.060	<.0005	143	<.01	<.05	.01	<.008	11.6	<.5
2273-2014 SW3	<.005	.06	.192	.651	<.0005	133	<.01	<.05	.02	.009	35.9	11.4
2273-2015 SW4	<.005	<.01	.450	.323	<.0005	162	<.01	<.05	.01	<.008	11.5	18.1
CONTROL DATA	--	--	--	--	--	--	--	--	--	--	--	--
BLANK	<.005	<.01	<.004	<.005	<.0005	.05	<.01	<.05	<.01	<.008	<.01	<.5
2273-2009	<.005	<.01	.532	.030	<.0005	205	<.01	<.05	<.01	<.008	.32	27.3
2273-2009-R	<.005	<.01	.524	.037	<.0005	147	<.01	<.05	<.01	<.008	.31	25.1
CONTROL STD	<.005	.99	.202	1.05	.0188	<.01	.20	.19	.20	.204	1.01	5
CONTROL.EST.	--	1.00	.200	--	.0200	--	.20	.20	.20	.200	1.00	-
EPA STD	<.005	.01	.106	<.005	<.0005	41.5	.01	<.05	<.01	<.008	.05	9.8
EPA.STD(CRT)	--	--	--	--	--	40.0	--	--	--	--	--	10.0

SAMPLE ID	MG MG/L	MN MG/L	MO MG/L	NA MG/L	NI MG/L	P MG/L	PB MG/L	SI MG/L	SR MG/L	TH MG/L	TI MG/L	V MG/L
2273-2009 L1	32.1	1.22	.4	332	<.05	<.5	<.05	11.0	.751	<.05	<.005	<.005
2273-2010 L2	38.2	.69	<.2	97.9	.07	.5	<.05	11.7	1.08	<.05	.008	<.005
2273-2012 SW1	43.5	.57	<.2	125	<.05	<.5	<.05	9.14	.345	<.05	<.005	<.005
2273-2013 SW2	20.5	.65	<.2	2.5	<.05	<.5	<.05	5.14	.212	<.05	<.005	<.005
2273-2014 SW3	39.3	.35	<.2	24.8	<.05	<.5	<.05	10.1	.344	<.05	<.005	<.005
2273-2015 SW4	42.0	.21	<.2	40.0	<.05	<.5	<.05	9.97	.401	<.05	<.005	<.005
CONTROL DATA	--	--	--	--	--	--	--	--	--	--	--	--
BLANK	.01	<.01	<.2	<.5	<.05	<.5	<.05	<.05	<.001	<.05	<.005	<.005
2273-2009	32.1	1.22	.4	332	<.05	<.5	<.05	11.0	.751	<.05	<.005	<.005
2273-2009-R	22.1	.94	.4	257	<.05	<.5	<.05	10.7	.667	<.05	<.005	<.005
CONTROL STD	<.01	.20	<.2	<.5	.20	<.5	.20	<.05	.205	<.05	.195	.187
CONTROL.EST.	--	.20	--	--	.20	--	.20	--	.200	--	.200	[illegible]
EPA STD	10.5	<.01	<.2	41.3	<.05	<.5	--	.52	.022	<.05	<.005	<.[illegible]5
EPA.STD(CRT)	10.0	--	--	40.0	--	--	--	--	--	--	--	--

BARRINGER MAGENTA
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DATE: 13/10/88
MATRIX: AQ

M.M.DILLON (KIRA ONYSKO) PROJ:2273-01 WO NO: 88-4504

SAMPLE ID	ZN MG/L	ZR MG/L	ALK PPMCACO3	AS UG/L	BOD MG/L	DOC MG/L	HG UG/L	NH3-N MG/L	PH	PHENOLS UG/L
2273-2009 L1	.04	<.05	1320	<1	57.0	122	.06	45.2	6.78	100
2273-2010 L2	.11	<.05	1350	<1	60.0	186	.16	25.5	6.81	380
2273-2012 SW1	.08	<.05	494	<1	9.8	7.1	.12	.66	7.46	<.5
2273-2013 SW2	.04	<.05	385	<1	12.5	8.3	.05	.05	7.38	.5
2273-2014 SW3	.06	<.05	462	1	24.0	12.4	<.05	24.6	7.07	1.5
2273-2015 SW4	.05	<.05	644	3	49.0	47.8	<.05	21.7	7.75	70.0
CONTROL DATA	--	--	--	--	--	--	--	--	--	--
BLANK	<.01	<.05	2.3	<1	.4	<.2	<.05	<.02	--	<.5
2273-2009	.04	<.05	1320	<1	57.0	122	.06	452	--	100
2273-2009-R	.04	<.05	1290	<1	59.5	117	.06	448	--	100
CONTROL STD	.22	.20	252	43	4.2	9.5	3.44	.52	--	9.5
CONTROL.EST.	.20	.20	250	45	4.0	10.0	3.20	.50	--	10.0
EPA STD	.02	<.05	--	--	--	--	--	--	--	--
EPA.STD(CRT)	--	--	--	--	--	--	--	--	--	--

SAMPLE ID	F- MG/L	CL- MG/L	NO2-N MG/L	PO4-3 MG/L	BR- MG/L	NO3-N MG/L	SO4= MG/L
2273-2009 L1	.30	32.2	<.10	<1.0	<.50	<.10	<.50
2273-2010 L2	.40	79.5	<.10	<1.0	<.50	<.10	<.50
2273-2012 SW1	.14	149	<.01	<.1	.28	.41	19.3
2273-2013 SW2	<.01	4.92	<.01	<.1	<.05	<.01	4.15
2273-2014 SW3	<.01	41.8	<.01	<.1	.25	1.26	25.0
2273-2015 SW4	<.01	56.1	<.01	<.1	.21	<.01	12.8
CONTROL DATA	--	--	--	--	--	--	--
BLANK	<.01	<.01	<.01	<.1	<.05	<.01	<.05
2273-2009	.30	32.2	<.10	<1.0	<.50	<.10	<.50
2273-2009-R	.30	33.0	<.10	<1.0	<.50	<.10	<.50
CONTROL STD	.62	1.94	.97	2.0	1.81	.43	1.83
CONTROL.EST.	.60	2.00	1.00	2.0	2.00	.45	2.00
EPA STD	--	--	--	--	--	--	--
EPA.STD(CRT)	--	--	--	--	--	--	--

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CUSTOMER: M.M. Dillon
47 Sheppard Ave. E.
Willowdale, Ontario
M2N 5X5

ATTN: Mrs. Kira Onysko

REPORT #: 882422 **CUSTOMER REF.#** 2270

DATE SUBMITTED: Oct. 20/88 **DATE REPORTED:** Oct. 20/88

---------------- CERTIFICATE OF ANALYSIS ----------------

Sample Description: **WATER**

Analysis Performed: **ACID-BASE/NEUTRAL EXTRACTABLES**

The analytical protocol used is based upon U.S. EPA Method #625.
Samples are fortified with isotopically labelled internal standards, solvent extracted at both acidic and basic pH's. The concentrated extracts are analyzed by capillary column gas chromatography/mass spectrometry (HRGC/MS).

Note: **Additional information is available on request.**

Instrumentation:

- Hewlett Packard 5890 GC
- Hewlett Packard 5970 Mass Selective Detector
- DB-5 0.25 mm I.D. 30 m column

Chemical Results: See Tables BN-1 and BN-2.

Todd Charters

CERTIFIED BY:
Nadine Armstrong, B.Sc.
Project Leader-Extractable Organics

WITNESSED BY:
Tim Munshaw, M.Sc. C.Chem.
Manager, Environmental Dept.

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T. Munshaw
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MIS-BN2
2422-BN2

SAMPLES RECEIVED: OCTOBER 20, 1988

CONC = ppb

BASE/NEUTRAL COMPOUNDS	MDL ug/l	% RECOVERY SPIKE	EXTRACTION BLANK	L1 2273-2018	L1 2273-2009	MDL	L2 2273-2010
BUTYL BENZYL PHTHALATE	1.0	90.2	--	--	--	10	--
3,3'-DICHLOROBENZIDENE	5.0	107	--	--	--	50	--
CHRYSENE	1.0	97.3	--	--	--	10	--
BENZO(A)ANTHRACENE	1.0	98.7	--	--	--	10	--
BIS-2-ETHYL HEXYL PHTHALATE	2.0	274	2.0+	2.0+	6.6+	20	151+
DI-N-OCTYL PHTHALATE	5.0	100.5	--	--	--	20	--
BENZO(B)FLUORANTHENE	2.0	91.3	--	--	--	20	--
BENZO(K)FLUORANTHENE	2.0	90.3	--	--	--	20	--
BENZO(A)PYRENE	5.0	96.2	--	--	--	50	--
PERYLENE	5.0	95.7	--	--	--	50	--
INDENO(1,2,3-CD) PYRENE	10.0	95	--	--	--	100	--
DIBENZO(A,H)ANTHRACENE	10.0	99.4	--	--	--	100	--
BENZO(GHI)PERYLENE	10.0	87.4	--	--	--	100	--
% RECOVERY D10 ANTHRACENE		--	--	--	--	--	--
PHENOLIC COMPOUNDS							
PHENOL	4.0	33.2	--	--	--	40	353
2-CHLOROPHENOL	3.0	73.3	--	--	--	30	--
O-CRESOL	4.0	74.1	--	20.3	29.9	40	319
P-CRESOL/M-CRESOL	8.0	75.0	--	168	171	80	1870
2-NITROPHENOL	3.0	86.2	--	--	--	30	--
2,4-DIMETHYL PHENOL	5.0	65.4	--	--	--	50	--
2,4-DICHLORO PHENOL	2.0	85.5	--	3.0	3.4	20	--
2,6-DICHLOROPHENOL	2.0	86.3	--	--	--	20	--
P-CHLORO-M-CRESOL	3.0	98.0	--	--	--	30	--
2,3,5-TRICHLOROPHENOL	2.0	93.4	--	--	--	20	--
2,4,6-TRICHLOROPHENOL	3.0	91.45	--	--	--	30	--
2,4,5-TRICHLOROPHENOL	3.0	94	--	--	--	30	--
2,3,4-TRICHLOROPHENOL	5.0	89.2	--	--	--	50	--
2,4-DINITROPHENOL	70	95.5	--	--	--	200	--
4-NITROPHENOL	40	45.4	--	--	--	400	--
2,3,5,6-TETRACHLOROPHENOL	4.0	94.6	--	--	--	40	--
2,3,4,6-TETRACHLOROPHENOL	4.0	89.9	--	--	--	40	--
2,3,4,5-TETRACHLOROPHENOL	4.0	98	--	--	--	40	--
4,6-DINITRO-O-CRESOL	12	99.2	--	--	--	120	--
PENTACHLORO PHENOL	20	103	--	--	--	20	--
SURROGATE % RECOVERY							
D4-2NITROPHENOL	-	74.8	86.0	70	62.75	-	61
D10-ANTHRACENE	-	81.6	78.0	66.9	65.4	-	84
QUALITATIVE SEARCH - ADDITIONAL COMPOUNDS							
TOLUENE-DI-ISOCYNATE	-	-	-	-	-	-	-

NA = NOT ADDED
MDL = METHOD DETECTION LIMIT
-- = NONE DETECTED
TR = TRACE AMOUNT DETECTED

\+ BIS-2-ETHYL HEXYL PHTHALATE NOT CORRECTED FOR % RECOVERY

ANALYST T.C, OCT 20 1988

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SAMPLES RECEIVED: OCTOBER 20, 1988

BASE/NEUTRAL COMPOUNDS	MDL ug/l	% RECOVERY SPIKE	EXTRACTION BLANK	L1 2273-2018	L1 2273-2009	MDL	L2 2273-2010
CAMPHENE	10.0	3.2	--	--	--	100	--
BIS(2-CHLORO ETHYL)ETHER	2.0	81.7	--	--	--	20	--
1,3-DICHLOROBENZENE	4.0	38.5	--	--	--	40	--
1,4-DICHLOROBENZENE	3.0	45.5	TR	7.83	7.5	30	--
1,2-DICHLOROBENZENE	3.0	52.3	--	--	--	30	--
BIS(2-CHLORO ISOPROPYL)ETHER	2.0	65.7	--	--	--	20	--
N-NITROSO-DI-N PROPYL AMINE	1.0	85.0	--	--	--	10	--
HEXACHLOROETHANE	5.0	19.5	--	--	--	50	--
NITROBENZENE	2.0	84.2	--	--	--	20	--
ISOPHORONE	1.0	88.3	--	--	--	10	--
BIS(2-CHLORO ETHOXY)METHANE	2.0	87.3	--	--	--	20	--
1,2,4-TRICHLOROBENZENE	3.0	50.5	--	--	--	30	--
NAPHTHALENE	2.0	70.4	--	13.8	13.4	20	--
HEXACHLOROBUTADIENE	6.0	14.0	--	--	--	60	--
2-METHYL NAPHTHALENE	2.0	69.4	--	--	--	20	--
INDOLE	2.0	93.4	--	--	--	20	--
1-METHYL NAPHTHALENE	2.0	76.4	--	--	--	20	--
HEXACHLOROCYCLOPENTADIENE	4.0	28.7	--	--	--	40	--
2-CHLORONAPHTHALENE	2.0	77.4	--	--	--	20	--
1-CHLORONAPHTHALENE	2.0	72.6	--	--	--	20	--
DIPHENYL ETHER	2.0	79.9	--	--	--	20	--
DIMETHYL PHTHALATE	1.0	87.9	--	--	--	10	--
2,6-DINITROTOLUENE	2.0	95.1	--	--	--	20	--
ACENAPHTHYLENE	1.0	80.3	--	--	--	10	--
ACENAPHTHENE	1.0	71.1	--	--	--	10	--
2,4-DINITROTOLUENE	1.0	92.5	--	--	--	10	--
DIETHYL PHTHALATE	1.0	92.2	--	19.8	18.3	10	309
FLUORENE	1.0	85.4	--	--	--	10	--
4-CHLORO PHENYL PHENYL ETHER	1.0	86.5	--	--	--	10	--
NITROSO DIPHENYL AMINE/	2.0	89.5	--	--	--	20	--
DIPHENYL AMINE	--	--	--	--	--	20	--
5-NITRO ACENAPHTHENE	--	--	--	--	--	--	--
1,2-DIPHENYL HYDRAZINE	2.0	84.2	--	--	--	20	--
4-BROMO PHENYL PHENYL ETHER	1.0	94.9	--	--	--	10	--
HEXACHLOROBENZENE	1.0	88.9	--	--	--	10	--
PHENANTHRENE	1.0	93.9	--	--	--	10	--
ANTHRACENE	1.0	92.7	--	--	--	10	--
DI-N-BUTYL PHTHALATE	2.0	105.3	--	TR	TR	20	--
FLUORANTHENE	1.0	103.8	--	--	--	10	--
BENZIDENE	10.0	--	--	--	--	100	--
PYRENE	1.0	103	--	--	--	10	--

NA = NOT ADDED
MDL = METHOD DETECTION LIMIT
-- = NONE DETECTED
TR = TRACE AMOUNT DETECTED

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ATTN: Ms. Kira Onysko

REPORT #: 882422

CUSTOMER REF.# 2273

DATE SUBMITTED: Sept. 2, 1988

DATE REPORTED: Nov. 1, 1988

------------------ **CERTIFICATE OF ANALYSIS** ----------------

Sample Description: **WATER**

Analysis Performed: **ORGANO-CHLORINE AND ORGANO-PHOSPHORUS PESTICIDE**

The analytical protocol is based upon U.S. EPA Method #8080/1986 Third Edition. Samples are solvent extracted at neutral conditions. The neutral extract is subjected to a florisil chromatographic cleanup procedure and analyzed by dual capillary column, dual electron capture detection gas chromatography (ECD^2/GC) and a nitrogen-phosphorus specific detection (TSD/GC).

Note: **Additional information is available on request.**

Instrumentation:

- Varian 3500 GC - dual ECD DB-5 0.25 mm I.D. 30, DB-1701 0.25 mm I.D. 30 m.
- Varian 3400 GC - equipped with an effluent splitter coupled with ECD and TSD; DB-17, 0.32 mm I.D. 30 m.

Chemical Results: See Tables 1, 2, 3.

Ewa Pranjic

CERTIFIED BY:
Ewa Pranjic, M.Sc., C.Chem.
Project Leader-Pesticide Section.

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
Eva Pranjic
CHEMIST

T. Munshaw

WITNESSED BY:
Tim Munshaw, M.Sc., C.Chem.

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2422-1

CHLORINATED PESTICIDES
Conc. = (ppt)

M.M. DILLON
W.O. #882422

PESTICIDE COMPOUNDS	MDL (ppt)	% RECOVERY	BLANK	L1 2273-2018	L1 2273-2009	
DELTA BHC	20	111	--	--	--	--
ALPHA BHC	20	93	--	--	--	--
BETA BHC	20	100	--	--	--	--
GAMMA BHC	20	101	--	--	--	--
4,4-DDD	20	109	--	--	--	--
4,4-DDE	20	106	--	--	--	--
4,4-DDT	20	100	--	--	--	--
ALDRIN	20	82	--	--	--	--
HEPTACHLOR	20	89	--	--	--	--
DIELDRIN	20	101	--	--	--	--
HEPTACHLOR EPOXIDE	20	110	--	--	--	--
ENDRIN	20	79	--	--	--	--
ALPHA ENDOSULPHAN	20	107	--	--	--	--
BETA ENDOSULPHAN	20	100	--	--	--	--
ENDOSULPHAN SULPHATE	20	106	--	--	--	--
ENDRIN ALDEHYDE	20	74	--	--	--	--
TOTAL PCB	500	98	--	--	--	--

MDL = METHOD DETECTION LIMIT
-- = NONE DETECTED
TR = TRACE AMOUNT DETECTED

ANALYST G. Poonzi NOV 1/88

2422-2

CHLORINATED PESTICIDES
Conc. = (ppt)

M.M. DILLON
W.O. #882422

PESTICIDE COMPOUNDS	MDL (ppt)	% RECOVERY	L2 2273-2010	BLF		
DELTA BHC	20	111	--	--	--	--
ALPHA BHC	20	93	--	--	--	--
BETA BHC	20	100	--	--	--	--
GAMMA BHC	20	101	--	--	--	--
4,4-DDD	20	109	--	--	--	--
4,4-DDE	20	106	--	--	--	--
4,4-DDT	20	100	--	--	--	--
ALDRIN	20	82	--	--	--	--
HEPTACHLOR	20	89	--	--	--	--
DIELDRIN	20	101	--	--	--	--
HEPTACHLOR EPOXIDE	20	110	--	--	--	--
ENDRIN	20	79	--	--	--	--
ALPHA ENDOSULPHAN	20	107	--	--	--	--
BETA ENDOSULPHAN	20	100	--	--	--	--
ENDOSULPHAN SULPHATE	20	106	--	--	--	--
ENDRIN ALDEHYDE	20	74	--	--	--	--
TOTAL PCB	500	98	--	--	--	--

MDL = METHOD DETECTION LIMIT
-- = NONE DETECTED
TR = TRACE AMOUNT DETECTED

ANALYST G. Pranji NOV 1/88

MANN

MANN TESTING LABORATORIES LTD.
5550 McADAM ROAD, MISSISSAUGA, ONTARIO L4Z 1P1
PHONE: 890-2555 • TELEX: 06-960496 • FAX: (416) 890-0370

CUSTOMER: M.M. Dillon
47 Sheppard Ave. East
Willowdale, Ontario
M2N 5X5

RECEIVED ENV-003

OCT 19 1988

M.M. DILLON LTD.
TORONTO OFFICE

ATTN: Mrs. Kira Onysko

REPORT #: 882422

CUSTOMER REF.# 2273

DATE SUBMITTED: Sept. 2, 1988

DATE REPORTED: Sept. 28/88

------------------ CERTIFICATE OF ANALYSIS ----------------

Sample Description: WATER

Analysis Performed: VOLATILE ORGANIC ANALYSIS

Protocol based upon U.S. EPA Method #624.
Samples are fortified with isotopically labelled internal standards and analyzed by purge and trap gas chromatography/mass spectrometry (PT-GC/MS).

Note: Additional information is available on request.

Instrumentation:

- Envirochem 810 purge and trap concentrator.
- Finnigan 3200 GC/MS-DS.

Chemical Results: See Tables V-1, V-2, V-3.

CERTIFIED BY:
Nellie Sio, B. Tech.
Project Leader-Volatile Organics

WITNESSED BY:
Tim Munshaw, M.Sc. C.Chem.
Manager, Environmental Dept.

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
T. Munshaw
CHEMIST

• Refer inquiries to.

2422-V-1
VOLATILE ORGANICS
Conc. = (ppb)

M.M. DILLON
W.O. #882422

VOLATILE COMPOUNDS	MDL (ppb)	TRAVELLING BLANK(1)	MDL (ppb)	L1 2273-2009	L2 2273-2010
DICHLORODIFLUOROMETHANE	2.0	--	120	--	--
CHLOROMETHANE	2.0	--	120	--	--
VINYL CHLORIDE	2.0	--	120	--	--
BROMOMETHANE	2.0	--	120	--	--
CHLOROETHANE	2.0	--	120	--	--
TRICHLOROFLUOROMETHANE	2.0	--	120	--	--
1,1-DICHLOROETHYLENE	1.0	--	60	--	--
DICHLOROMETHANE	1.0	TR	60	--	--
T-1,2-DICHLOROETHYLENE	1.0	--	60	--	--
1,1-DICHLOROETHANE	1.0	--	60	--	--
CHLOROFORM	1.0	4.75	60	78	--
1,2-DICHLOROETHANE	1.0	--	60	--	--
1,1,1-TRICHLOROETHANE	1.0	--	60	--	--
BENZENE	0.5	TR	30	45.24	60.20
CARBON TETRACHLORIDE	1.0	--	60	--	--
1,2-DICHLOROPROPANE	1.0	--	60	--	--
BROMODICHLOROMETHANE	1.0	--	60	--	--
TRICHLOROETHYLENE	1.0	--	60	--	--
1,3-DICHLOROPROPENE(Z)	1.0	--	60	--	--
1,3-DICHLOROPROPENE(E)	1.0	--	60	--	--
1,1,2-TRICHLOROETHANE	1.0	--	60	--	--
TOLUENE	0.5	3.38	30	64.25	7.33 ppm
DIBROMOCHLOROMETHANE	1.0	--	60	--	--
TETRACHLOROETHYLENE	1.0	--	60	--	--
CHLOROBENZENE	0.5	--	30	--	--
ETHYL BENZENE	0.5	.64	30	482.39	117.87
P & M XYLENE	0.5	1.38	30	1.06 ppm	247.64
BROMOFORM	1.0	--	60	--	--
O-XYLENE	0.5	.79	30	624.59	165.44
1,1,2,2-TETRACHLOROETHANE	1.0	--	60	--	--
1,3-DICHLOROBENZENE	1.0	--	60	--	--
1,4-DICHLOROBENZENE	1.0	--	60	--	--
1,2-DICHLOROBENZENE	1.0	--	60	--	--
CIS-1,2-DICHLOROETHYLENE	1.0	--	60	--	--
TOLUENE DISSOCYANATE			5 ppm		
*OTHER COMPOUNDS DETECTED					
THF				62.40	35.51
METHYL PENTANONE				73.39	
TOTAL C3-BENZENES				614.03	
TOTAL C4-BENZENES				285.27	
TOTAL KETONES					340.78
SURROGATE % RECOVERY					
4-BROMOFLUOROBENZENE		81.93%		89.23%	89.27%

* = SEMI-QUANTITATIVE VALUES ONLY
TR = TRACE AMOUNT DETECTED
-- = NONE DETECTED
MDL = METHOD DETECTION LIMIT

ANALYST [signature] Oct-13/88

MANN TESTING LABORATORIES LTD.

2422-V-2
VOLATILE ORGANICS
Conc. = (ppb)

M.M. DILLON
W.O. #882422

VOLATILE COMPOUNDS	MDL (ppb)	L1 2273-2018			
DICHLORODIFLUOROMETHANE	120	--	--	--	--
CHLOROMETHANE	120	--	--	--	--
VINYL CHLORIDE	120	--	--	--	--
BROMOMETHANE	120	--	--	--	--
CHLOROETHANE	120	--	--	--	--
TRICHLOROFLUOROMETHANE	120	--	--	--	--
1,1-DICHLOROETHYLENE	60	--	--	--	--
DICHLOROMETHANE	60	--	--	--	--
T-1,2-DICHLOROETHYLENE	60	--	--	--	--
1,1-DICHLOROETHANE	60	--	--	--	--
CHLOROFORM	60	--	--	--	--
1,2-DICHLOROETHANE	60	--	--	--	--
1,1,1-TRICHLOROETHANE	60	--	--	--	--
BENZENE	30	--	--	--	--
CARBON TETRACHLORIDE	60	--	--	--	--
1,2-DICHLOROPROPANE	60	--	--	--	--
BROMODICHLOROMETHANE	60	--	--	--	--
TRICHLOROETHYLENE	60	--	--	--	--
1,3-DICHLOROPROPENE(Z)	60	--	--	--	--
1,3-DICHLOROPROPENE(E)	60	--	--	--	--
1,1,2-TRICHLOROETHANE	60	--	--	--	--
TOLUENE	30	74.36	--	--	--
DIBROMOCHLOROMETHANE	60	--	--	--	--
TETRACHLOROETHYLENE	60	--	--	--	--
CHLOROBENZENE	30	--	--	--	--
ETHYL BENZENE	30	284.09	--	--	--
P & M XYLENE	30	611.51	--	--	--
BROMOFORM	60	--	--	--	--
O-XYLENE	30	330.47	--	--	--
1,1,2,2-TETRACHLOROETHANE	60	--	--	--	--
1,3-DICHLOROBENZENE	60	--	--	--	--
1,4-DICHLOROBENZENE	60	--	--	--	--
1,2-DICHLOROBENZENE	60	--	--	--	--
CIS-1,2-DICHLOROETHYLENE	60	--	--	--	--
TOLUENE DISSOCYANATE	5 ppm		--		
SURROGATE % RECOVERY					
4-BROMOFLUOROBENZENE		78.20%			

TR = TRACE AMOUNT DETECTED
-- = NONE DETECTED
MDL = METHOD DETECTION LIMIT

ANALYST [illegible], Oct 13/88

2455MISA

MTL QA/QC REFERENCE MATERIAL ANALYSIS
FOR THE PERIOD OF SEPT. 8 - SEPT. 20
U.S. EPA MATERIAL WS1084 - I & IV

VOLATILE COMPOUNDS	MDL (ppb)	EPA REFERENCE MATERIALS			
		EPA VALUES	LAB VALUES	% RECOVERY	
DICHLORODIFLUOROMETHANE	2.0	--	--	--	--
CHLOROMETHANE	2.0	--	--	--	--
VINYL CHLORIDE	2.0	--	--	--	--
BROMOMETHANE	2.0	--	--	--	--
CHLOROETHANE	2.0	--	--	--	--
TRICHLOROFLUOROMETHANE	2.0	--	--	--	--
1,1-DICHLOROETHYLENE	1.0	10.0	8.87	88.70	--
DICHLOROMETHANE	1.0	--	--	--	--
T-1,2-DICHLOROETHYLENE	1.0	--	--	--	--
1,1-DICHLOROETHANE	1.0	--	--	--	--
CHLOROFORM	1.0	--	--	--	--
1,2-DICHLOROETHANE	1.0	--	--	--	--
1,1,1-TRICHLOROETHANE	1.0	9.9	10.06	101.62	--
BENZENE	0.5	9.82	10.38	105.70	--
CARBON TETRACHLORIDE	1.0	--	--	--	--
1,2-DICHLOROPROPANE	1.0	--	--	--	--
BROMODICHLOROMETHANE	1.0	--	--	--	--
TRICHLOROETHYLENE	1.0	--	--	--	--
1,3-DICHLOROPROPENE(Z)	1.0	--	--	--	--
1,3-DICHLOROPROPENE(E)	1.0	--	--	--	--
1,1,2-TRICHLOROETHANE	1.0	10.1	6.46	63.96	--
TOLUENE	0.5	--	--	--	--
DIBROMOCHLOROMETHANE	1.0	--	--	--	--
TETRACHLOROETHYLENE	1.0	10.0	7.46	74.6	--
CHLOROBENZENE	0.5	--	--	--	--
ETHYL BENZENE	0.5	10.0	10.80	108	--
P & M XYLENE	0.5	9.8	9.69	98.88	--
BROMOFORM	1.0	10.2	6.74	66.08	--
O-XYLENE	0.5	--	--	--	--
1,1,2,2-TETRACHLOROETHANE	1.0	--	--	--	--
1,3-DICHLOROBENZENE	1.0	--	--	--	--
1,4-DICHLOROBENZENE	1.0	10.0	7.96	79.60	--
1,2-DICHLOROBENZENE	1.0	--	--	--	--
CIS-1,2-DICHLOROETHYLENE	1.0	10.2	7.33	71.86	--
ACROLEIN	15.0	--	--	--	--
ACRYLONITRILE	15.0	--	--	--	--
DIBROMOMETHANE	1.0	--	--	--	--
1,2-DIBROMOETHANE	1.0	--	--	--	--
1,3-BUTADIENE	2.0	--	--	--	--
STYRENE	1.0	--	--	--	--
PROPYL BENZENE	0.5	--	--	--	--
CUMENE	0.5	--	--	--	--
4-ETHYL TOLUENE	0.5	--	--	--	--
1,2,4-TRIMETHYL BENZENE	0.5	--	--	--	--
1,4-DIETHYL BENZENE	0.5	--	--	--	--

ANALYST [illegible], Sept 29/88

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LEACHATE GENERATION AT NEWTON LANDFILL
CAMBRIDGE, ONTARIO
JANUARY 2, 1989

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GOOD GRASS

LAYER 1

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VERTICAL PERCOLATION LAYER
THICKNESS                             =    30.00 INCHES
EVAPORATION COEFFICIENT               =     3.300 MM/DAY**0.5
POROSITY                              =     0.3710 VOL/VOL
FIELD CAPACITY                        =     0.1720 VOL/VOL
WILTING POINT                         =     0.0500 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY      =    22.68000031 INCHES/HR
```

LAYER 2

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VERTICAL PERCOLATION LAYER
THICKNESS                             =   300.00 INCHES
EVAPORATION COEFFICIENT               =     3.300 MM/DAY**0.5
POROSITY                              =     0.5200 VOL/VOL
FIELD CAPACITY                        =     0.3200 VOL/VOL
WILTING POINT                         =     0.1900 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY      =     0.28299999 INCHES/HR
```

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	80.00
TOTAL AREA OF COVER	=	550000. SQ. FT
EVAPORATIVE ZONE DEPTH	=	10.00 INCHES
EFFECTIVE EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
UPPER LIMIT VEG. STORAGE	=	3.7100 INCHES
INITIAL VEG. STORAGE	=	1.1100 INCHES

CLIMATOLOGIC DATA FOR SYRACUSE NEW YORK

MONTHLY MEAN TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.48	23.03	30.59	42.12	54.54	64.52
69.39	67.83	60.28	48.75	36.33	26.35

MONTHLY MEANS SOLAR RADIATION, LANGLEYS PER DAY

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
106.33	164.90	260.07	366.34	455.24	502.95
496.67	438.10	342.93	236.66	147.76	100.05

LEAF AREA INDEX TABLE

DATE	LAI
1	0.00
121	0.00
138	1.23
155	2.01
171	2.01
188	2.01
205	2.01
222	2.01
239	1.81
255	1.31
272	0.64
289	0.34
366	0.00

GOOD GRASS

WINTER COVER FACTOR = 1.20

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AVERAGE MONTHLY TOTALS FOR 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	2.54	2.00	2.95	2.27	2.79	3.14
	3.13	4.15	4.19	2.38	3.23	2.41
RUNOFF (INCHES)	0.000	0.000	0.000	0.005	0.001	0.025
	0.008	0.491	0.003	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.694	0.994	2.035	1.924	1.227	1.630
	1.594	1.575	1.805	0.846	0.785	0.724
PERCOLATION FROM BASE OF COVER (INCHES)	0.0124	0.0007	0.5155	4.5019	1.5747	1.6793
	1.4989	1.8013	2.2885	1.8909	2.1550	0.4958
DRAINAGE FROM BASE OF COVER (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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AVERAGE ANNUAL TOTALS FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	35.20	1613242.	100.00
RUNOFF	0.533	24440.	1.51
EVAPOTRANSPIRATION	15.832	725650.	44.98
PERCOLATION FROM BASE OF COVER	18.4150	844020.	52.32
DRAINAGE FROM BASE OF COVER	0.000	0.	0.00

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PEAK DAILY VALUES FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	5.92	271333.3
RUNOFF	2.440	111824.8
PERCOLATION FROM BASE OF COVER	0.3485	15974.6
DRAINAGE FROM BASE OF COVER	0.000	0.0
HEAD ON BASE OF COVER	0.0	
SNOW WATER	7.00	320690.9

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.1195

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0500

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